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OCTOBER, 1923

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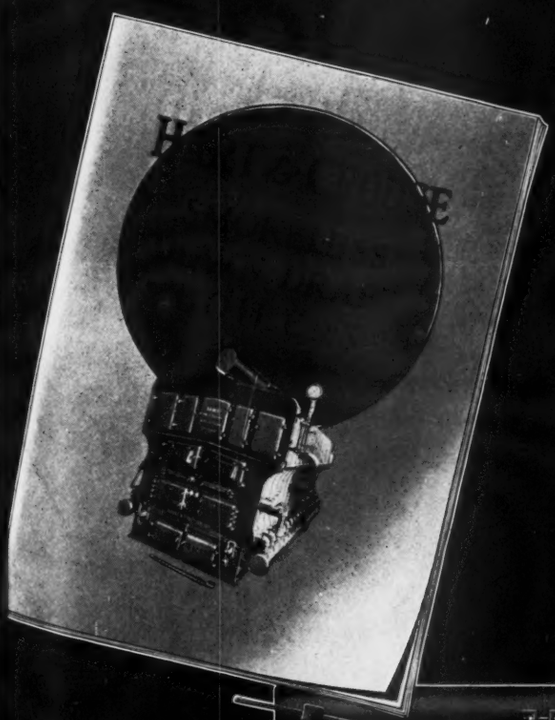

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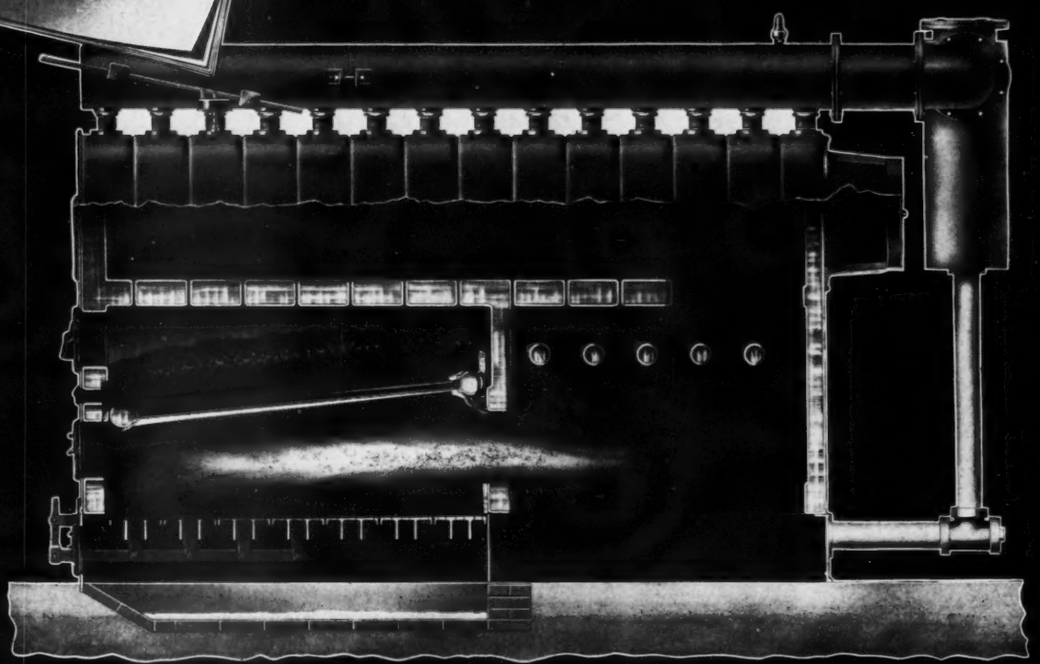

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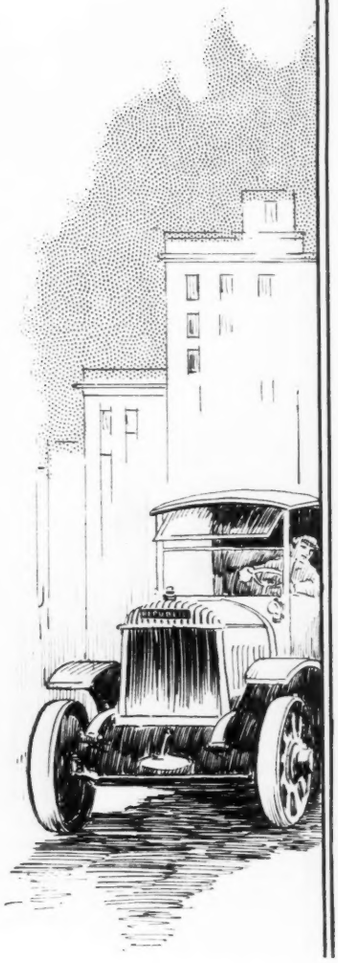

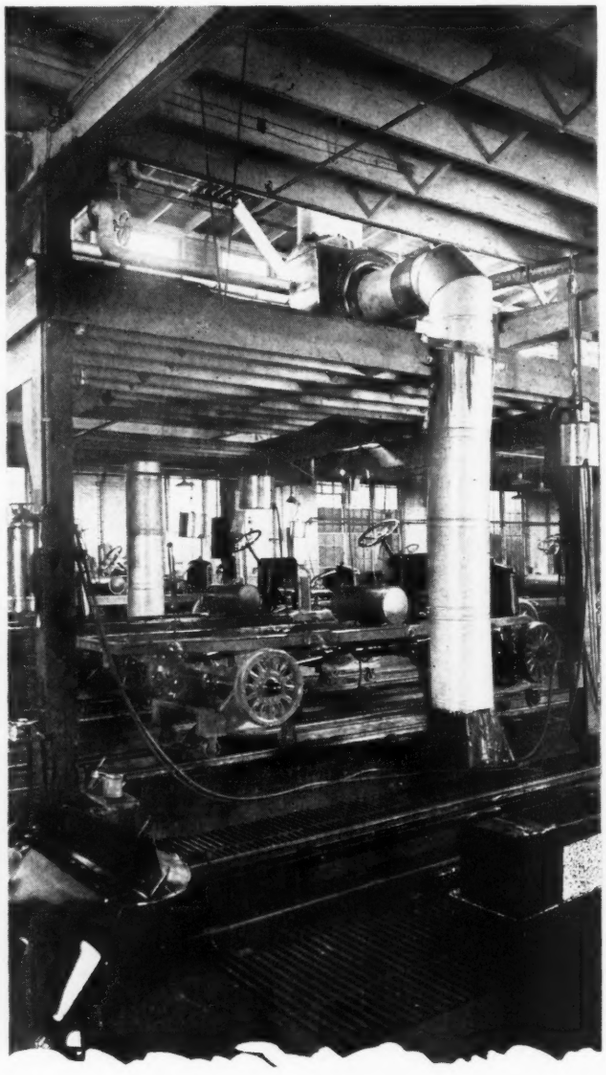

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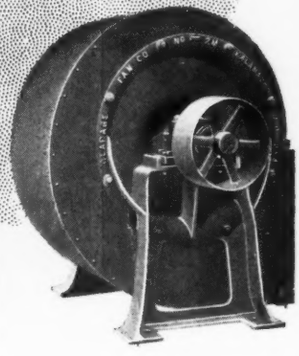

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Send for list of references of school installations and complete data regarding the Spencer equipment.

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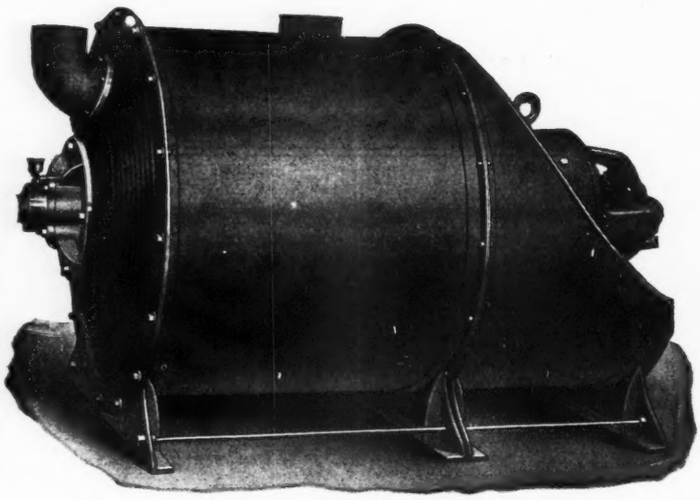

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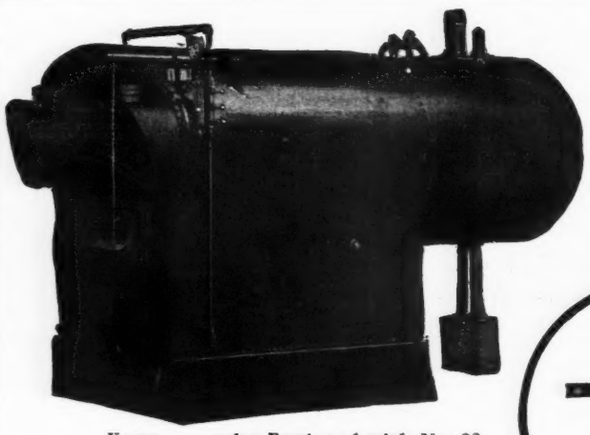

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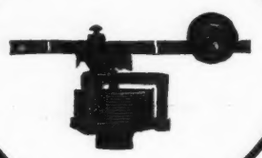
Sylphon N°22 Damper Regulator



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A Monthly Journal of Engineering Progress.

OCTOBER, 1923

The Denver Residence Gas-Heating Experiment

Detailed Report of the Conditions Under Which This Program is Being Conducted, the Methods and Experience Relative to Installations and the Economic Results Obtained

By T. M. Foulk and T. G. Storey

Engineer of Utilization and Superintendent, Respectively, House Heating Division, Denver Gas & Electric Light Company.

(Presented at the Fifth Annual Convention of the American Gas Association, Atlantic City, October 15-19, 1923.)

DURING the winter of 1922-1923 the Denver Gas & Electric Light Company inaugurated an experimental program of residence heating with gas. It may be interesting to consider first some of the general heating situations existing in Denver. In the first place, the city is located in the heart of Colorado's lignite beds, which makes available an abundant supply of comparatively cheap fuel. It also has extraordinary temperature conditions. A survey of average monthly temperatures prevailing in Baltimore, Chicago, Portland, Los Angeles, St. Louis, San Francisco and Denver for the past fifty years (Fig. 1) shows that Denver has the lowest average temperature during the heating season, with the exception of Chicago. In addition to this, it is subjected to wide variations and sudden changes in temperature during the winter months. Consequently, a fuel that readily lends itself to meet such conditions has decided advantages.

Another point of interest, bearing on the general heating situation, is the fact that a gas, low in heating value, is being successfully utilized; this value being 400 B. T. U., 30 in. hg. and 60° F.

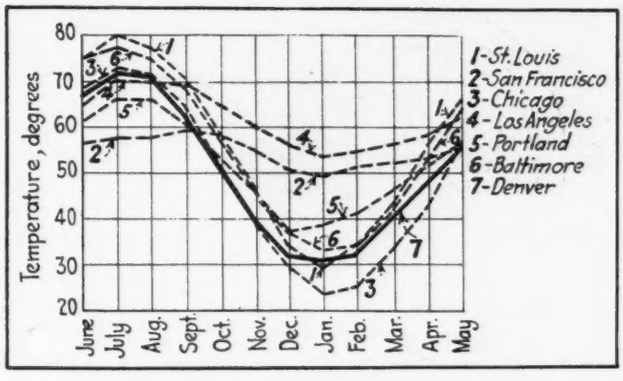


Fig. 1—Average Monthly Temperatures for the Past Fifty Years in Seven Representative Cities.

THE SELECTION OF A SUITABLE RATE.

The most important preliminary step was the selection of a suitable rate. After a study of the situation, the following three-part was adopted:

Rate U—House-Heating Service—Temporary Three-Part Rate. Available to any customer for house-heating and other domestic fuel purposes.

Rate (Three Parts):

(1) A Customer Charge: Per customer per annum, $9.00 (payable in twelve equal installments).

(2) A Demand Charge: Per 100 cu. ft. of maximum hourly demand, per annum, $21.00 (payable in twelve equal installments).

(3) A Consumption Charge: Per 1000 cu. ft. of gas metered, $0.40.

Discount: For payment of any bill within ten days after it is dated, 10%.

Under the rate, the customer's maximum hourly demand is determined by actual test after the installation has been completed.

BASIS FOR ESTIMATING HEATING COSTS TO CUSTOMER.

Another important preliminary step was the selection of a basis for estimating the heating costs to the

customer. To assist in this, the following formulas were used, which give approximate gas consumptions:

1. Warm Air. Cubical contents of the building in

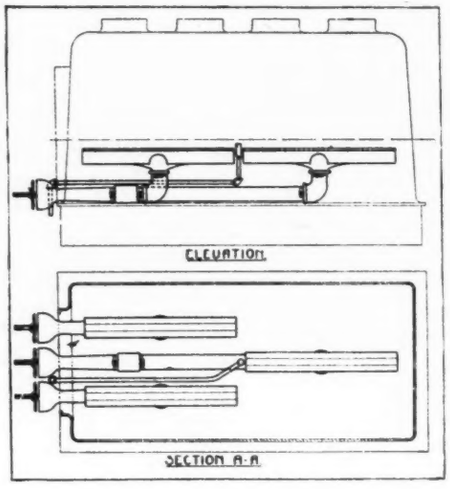


Fig. 2—Design of Gas Burner Equipment.

feet, multiplied by 3, gives the average gas consumption in cubic feet per month for eight months.

2. Hot water. The number of square feet of radiation, multiplied by 120, gives the average gas consumption per month for the eight months.

3. Steam. The number of square feet of radiation, multiplied by 240, gives the average gas consumption per month for eight months.

The demand to be established for an installation is governed by the size of boiler, number of burners used, and the requirements of the customer.

Gas-fired boilers are selected to take care of the necessary amount of radiation. A demand of 70 cu. ft. per boiler section is used to determine the maximum hourly demand, as the burners are adjusted by the manufacturer.

The size of warm-air furnaces depends upon the cubical contents of the building, which in turn controls the number and size of burners to be used, and consequently the demand. These demands range from 250 to 500 cu. ft. per hour.

In the case of the conversion of coal-fired boilers to burn gas, the demand is dependent upon the number and size of burners required for that particular size of boiler.

METHODS OF INSTALLATION.

The installations in Denver may be divided into three main classes: gas-fired warm-air furnaces, coal-fired boilers converted to burn gas, and gas-designed boilers.

1. Warm-Air Furnaces. Several types of gas-fired warm-air furnaces were installed. The standards of construction are not up to those of the gas-fired boilers

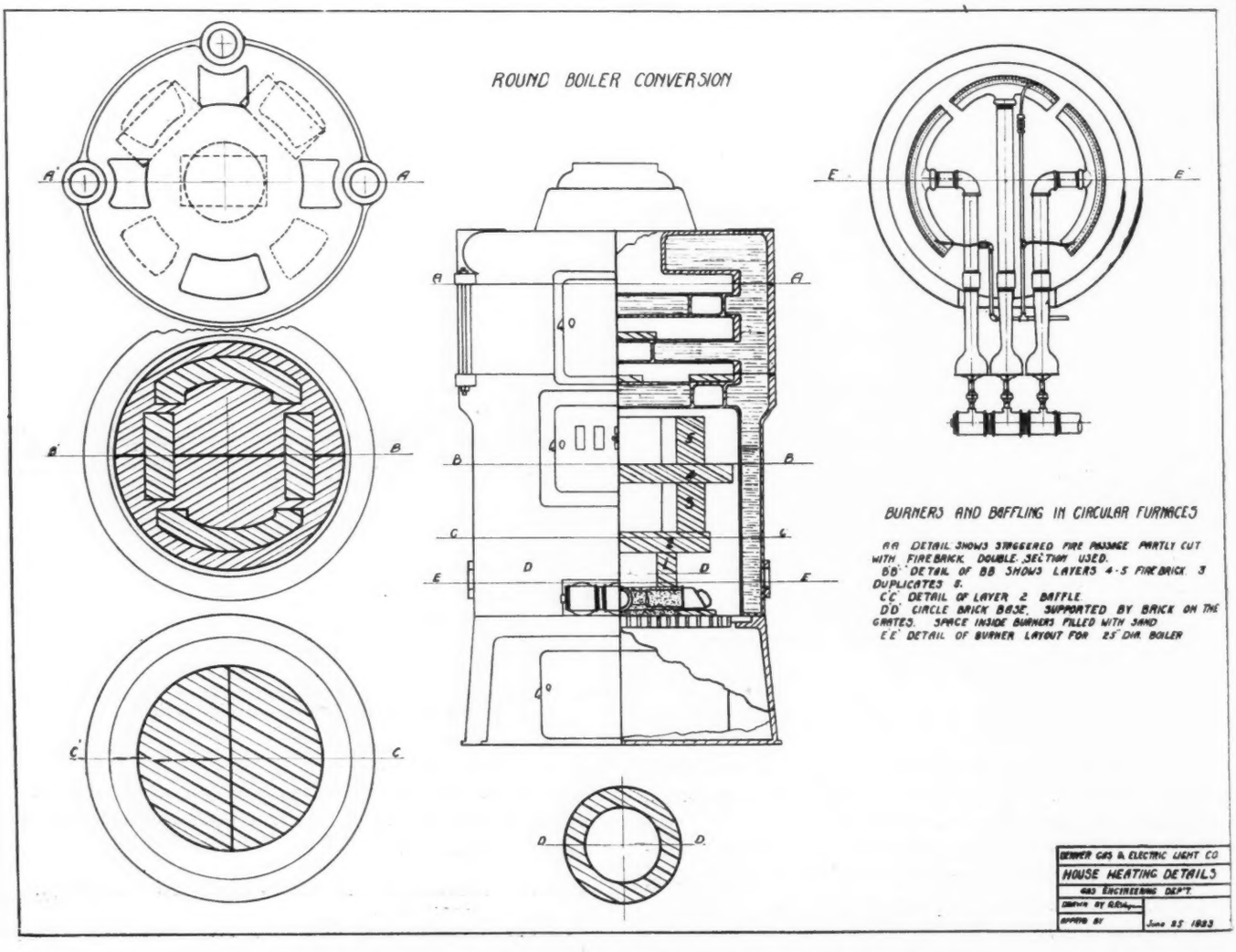

ROUND BOILER CONVERSION
BURNERS AND BAFFLING IN CIRCULAR FURNACES
AA DETAIL SHOWS STAGGERED FIRE PASSAGE PARTLY CUT WITH FIRE BRICK. DOUBLE SECTION USED.
BB DETAIL OF BB SHOWS LAYERS 4-5 FIRE BRICK 3 DUPLICATES 6.
CC DETAIL OF LAYER 2 BAFFLE
DD CIRCLE BRICK BASE. SUPPORTED BY BRICK ON THE GRATES. SPACE INSIDE BURNERS FILLED WITH SAND
EE DETAIL OF BURNER LAYOUT FOR 25" DIA. BOILER
DENVER GAS & ELECTRIC LIGHT CO
HOUSE HEATING DETAILS
GAS ENGINEERING DEPT
June 25 1923

Fig. 3—System Used in Round Boilers Converted from Coal to Gas.

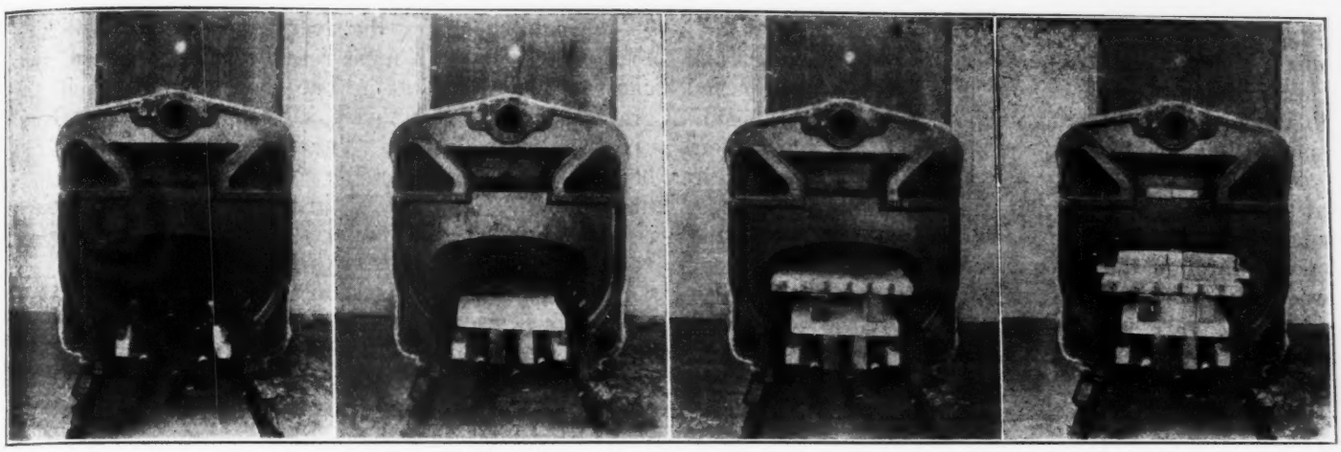


Fig. 4 Fig. 5 Fig. 6 Fig. 7

System Used in Sectional Boilers Converted from Coal to Gas.

since these furnaces were all constructed of sheet-metal. Some doubts were entertained about the lasting qualities of an all sheet-metal furnace. Special mention might be made of one type which was made of large drums and could not be taken through the ordinary door, so it was necessary, in some cases, to cut a passage through the foundation.

As all the manifolds and mixers were designed for natural gas, they had to be replaced by equipment designed for manufactured gas. This equipment is shown in Fig. 2.

Warm-air furnaces were sold in three sizes, for $100.00, $121.50 and $140.00 respectively. The average cost of installing the furnaces was around $100.00. Some of the older places ran higher, for in all cases an inside cold-air duct was required, and any additional piping deemed necessary to insure satisfaction. A thorough check was made in all cases before signing the customer, and all changes agreed upon.

2. Conversions. A standardization of burners and baffling used in the conversion of coal-fired boilers to burn gas was hampered somewhat by the difference in design of the boilers undertaken. The systems shown in the sketch of a round conversion (Fig. 3) and illustrations of a sectional boiler conversion (Figs. 4, 5, 6 and 7) were followed as closely as possible.

Since experiment and theory indicated that the best results were to be obtained when the flames impinged upon the water leg, burners that would fulfill this condition were desired. Straight cast-iron tee burners in three sizes and circular cast-iron burners in two sizes were used. Throat mixers were designed, as shown in

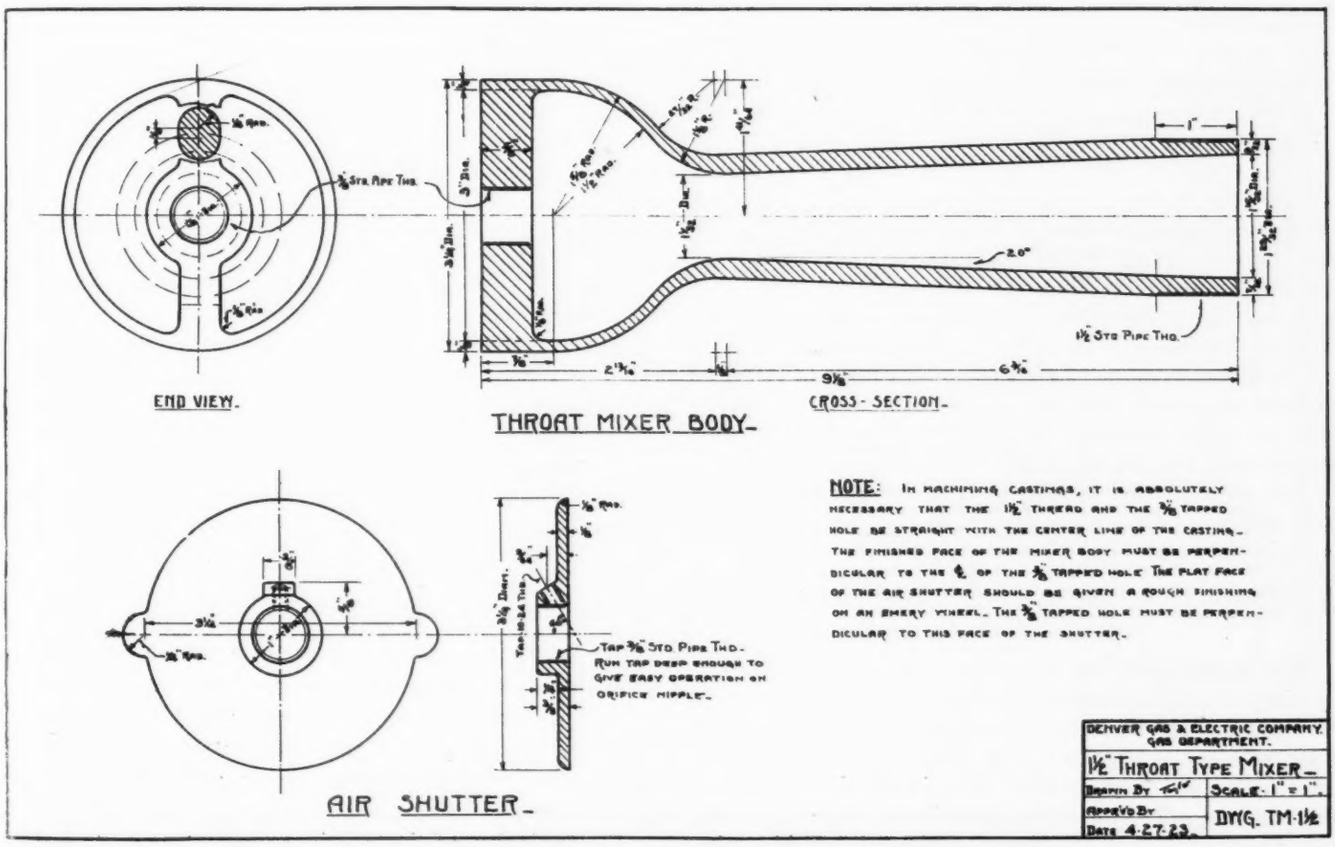

END VIEW.
CROSS-SECTION.
THROAT MIXER BODY.
AIR SHUTTER.
NOTE: IN MACHINING CASTINGS, IT IS ABSOLUTELY NECESSARY THAT THE 1½" THREAD AND THE ⅜ TAPPED HOLE BE STRAIGHT WITH THE CENTER LINE OF THE CASTING. THE FINISHED FACE OF THE MIXER BODY MUST BE PERPENDICULAR TO THE ℄ OF THE ⅜ TAPPED HOLE. THE FLAT FACE OF THE AIR SHUTTER SHOULD BE GIVEN A ROUGH FINISHING ON AN EMERY WHEEL. THE ⅜ TAPPED HOLE MUST BE PERPENDICULAR TO THIS FACE OF THE SHUTTER.
DENVER GAS & ELECTRIC COMPANY. GAS DEPARTMENT.
1½" THROAT TYPE MIXER.
SCALE 1" = 1".
DWG. TM-1½
DATE 4-27-23.

Fig. 8—Design of Throat Mixers Used in Denver Experiments.

Fig. 8, with threaded ends, so that the burners and mixers might be connected with 1½-in. pipe, and threaded joints, with mixing and burner tubes butted together, thus preventing eddies, and creating a substantial joint, which held the burners firmly in position.

After selecting the burners and mixers, the problem of their placing in the boiler was considered. The most convenient and desirable method was to insert the mixers through the clinker door. If the clinker door was too small, the mixers were put through the ash door and part of the grates removed. When the grates were removed, a support for the burners and baffling was made of strap-iron.

IMPORTANCE OF BAFFLING

Baffling from a standpoint of efficiency of operation is the most important part of the conversion. Good baffling requires a great amount of care and experience on the part of the workman, with close adherence to that arrangement which has been found to give the best results. A variety of methods have been tried, and the one shown in Fig. 3 was adopted for round boilers.

A circle brick (section D′ D′) 4 in. to 6 in. high, and with a diameter 3 in. to 4 in. less than the burner ring, forms the base piece, as shown in layer 1. Two flat tile, forming a circle 6 in. smaller in diameter than the fire-pot, form layer 2 (section C′ C′). Layers 3 and 5 are formed from two arches 3 in. thick and 5 in. high (section B′ B′) while layer 4 is made of flat tile, with a diameter 2 in. smaller than the water leg. Layers 3 and 4 are repeated alternately until the top of the section is reached. Firebrick splits are used to partially close the gas passages in the boiler above the firepot, thus increasing the length of fire travel, rate of flow and diffusion of gases.

The baffling for sectional boilers follows the outline for round boilers, as is shown in Figs. 4, 5, 6 and 7. The lower layer is kept 3 in. and the succeeding layers 1 in. from the water-leg.

PILOT LIGHTS AND OTHER DETAILS.

The pilot lights for conversions are made of ⅜-in. copper tubing, split down 2 in. and flattened so that a flat flame results. This tube is curled over the end of the burner to insure ignition. Pilots are so placed that they may be easily lighted and seen. They burn on the average about 7 cu. ft. per hour.

The door through which the mixers enter is removed and the opening is partially bricked up. Sufficient openings are left for secondary air and the job is finished neatly with a good grade of cement.

The piping, valves and manifold are standardized to 2-in. fittings. The manifold is made up of a 2-in. x 2-in. x ¾-in. tees and close nipples.

DIFFICULTY OF USING WATER COILS IN CONVERTED BOILERS.

The water coils were always removed before converting a boiler. It was found that their presence interfered so greatly with the setting of a baffle that poor efficiencies resulted. In one or two cases coils have been used to good advantage in the flue, reducing the stack temperature; however, in all cases standard gas water-heaters have more efficiently provided for hot water requirements.

The equipment for the average conversion amounts to about $65.00. In most cases, two experienced men can complete the job in one day, though when the grates have to be removed, a longer time is required.

3. Gas-fired Boilers. The first cost of a gas-fired boiler is little more than the cost of an equivalent coal-fired boiler. The cost of installing a gas-fired boiler is very low, since the boiler stands on the floor, takes very little room and requires no pit.

After a gas-heating system was installed and operating, a flue-gas analysis, including a determination of CO_2, O_2 and CO, and stack temperatures, was taken. From the analysis the need of adjustments could be readily seen and changes were made until a good analysis was obtained.

Increased efficiencies in operation were obtained principally by reducing stack losses. The burners used were cast on good principles, both from design and operation standpoints. Radiation losses were reduced to a minimum by the proper us of good insulating materials in jacketing the boiler and piping.

The stack losses were the only losses that could not be easily controlled, being the sum of several factors which must of necessity be considered and adjusted simultaneously, such as gas pressure and rate, secondary air adjustment, baffling, drafts, check valves and dampers.

The adjustments on gas-designed equipment were easily and quickly made, while those on conversions often required considerable time. Since no two boilers operated under the same conditions of flue connections, cut-and-try methods were used. If CO appeared in the analysis, the secondary air openings were enlarged and dampers adjusted. Generally, the air was in excess and openings and dampers had to be closed.

IMPORTANCE OF ADJUSTMENT OF SECONDARY AIR.

The proper adjustment of secondary air is very important. All air in excess of that required for proper combustion, which enters the furnace, is heated up when passing through the combustion chamber and in the stack, absorbing heat which is lost in the open air. While it is neither desirable nor practical from the standpoint of satisfactory operation to decrease the secondary air to the theoretically proper amount, the over-ventilation in most cases was greatly reduced. Experiments led to the conclusion that approximately 25-40% over-ventilation with gas-designed equipment, and 40-55% for conversions would give satisfactory results under all conditions. In calculating stack losses the moisture content of the flue gases was taken into account. It was found that the average stack losses for the gas-designed boilers were 12% and those of the warm-air furnaces and conversions were 15%.

OVERFLOW IN WATER PANS WITH AUTOMATIC CONTROL

Very little trouble occurred during the past season. The automatic water pans on the warm-air furnaces gave some trouble from valves and resultant overflows. This was eliminated by manual control of the water valve. Some trouble resulted from pilots carbonizing, but this was very small.

The majority of installations were thermostatically controlled, and such control was strongly urged. The

Table 1—Summary of House-Heating Data Secured in Denver Experiments, Comprising 36 Representative Installations.

SUMMARY OF HOUSE HEATING DATA - SEASON 1922 - 1923

THE DENVER GAS AND ELECTRIC LIGHT COMPANY

NO.	TYPE OF INSTALLATION	NO. ROOMS	RAD. Sq. ft.	CUBICAL CONTENTS Cu. ft.	HEATING DEMAND Cu. ft	GAS CONSUMPTION HEATING ONLY M. Cu. ft OCT.	NOV.	DEC.	JAN	FEB.	MAR.	APR.	MAY.	SEASON	HEATING COSTS GAS R/S CHARGE	GAS TOTAL	GAS MILLION B.T.U.	COAL TONS	COAL TOTAL	COAL MILLION B.T.U.	B.T.U./Cu. ft. CONTENTS SEASON	DEMAND 1000 Cu. ft. CONTENTS Cu. ft.	HOURS USE DEMAND SEASON	RATIO B.T.U. FIRED GAS TO COAL	COST OF COAL REPLACING MILLION B.T.U. GAS
1	Penna. #20	6		12 000	220	°10.3	°51.6	53.0	58.1	65.1	56.5	27.9	14.8	337.3	45.90	167.33	1.54	10	108.	0.49	9 020	18.3	1 532	.490	1.00
2	Penna. #24	6		16 500	300	°15.9	°78.4	91.0	75.7	105.4	87.7	50.0	25.6	529.7	64.80	255.49	1.50	12	135.	.51	10 300	18.2	1 766	.645	0.79
3	High Eff. #23	7		15 550	300	°13.2	71.3	85.2	68.5	83.1	68.3	35.3	15.1	440.0	64.80	223.20	1.53	15	150.	.50	9 080	19.3	1 466	.430	1.16
4	Penna. #24	6		14 050	270	°10.8	53.9	58.2	53.4	61.9	67.2	32.9	22.4	360.7	55.35	185.20	1.60	No	Data		8 230	19.2	1 316		
5	Popular	5		10 000	265	°13.4	46.2	53.0	55.5	67.0	64.2	29.4	19.3	348.0	55.35	180.63	1.61	9	88.	.49	11 170	26.5	1 310	.563	0.87
6	Penna. #24	6		12 000	200	°11.5	°56.6	73.1	68.4	67.3	58.0	29.3	13.2	377.4	45.90	181.76	1.50	9	100.	.50	10 100	16.7	1 885	.614	0.82
7	High Eff. #123	7		16 000	400	° 9.7	52.9	56.2	59.4	59.4	62.9	19.9	9.6	330.0	83.70	202.50	1.92	10	150.	.58	6 600	25.0	825	.442	1.31
8	Penna. #24	9		22 000	340	°21.3	102.0	116.0	117.0	129.0	120.3	78.4	41.0	725.0	74.25	335.25	1.44	20	175.	.44	10 600	15.4	2 132	.585	0.75
9	Popular	4		5 400	230	° 7.6	45.7	44.1	38.6	41.3	40.9	24.2	7.1	249.5	55.35	145.17	1.81	7	50.	.42	14 800	42.6	1 083	.812	0.52
10	Penna. #24	6		13 600	300	°11.8	° 59.2	68.7	58.6	68.5	64.5	39.1	23.0	393.4	64.80	206.42	1.63	10	125.	.63	9 300	22.1	1 311	.571	1.10
11	" #24	6		13 000	300	°11.4	° 47.2	55.3	50.5	53.0	46.5	28.3	8.2	300.4	64.80	172.94	1.79	8	71.	.44	7 420	23.0	1 001	.600	0.73
12	" #24	8		24 000	250	°11.9	° 59.5	69.7	57.5	72.9	71.0	38.1	17.0	397.6	55.35	198.49	1.56	12	120.	.50	5 250	10.3	1 590	.533	0.94
13	High Eff. #123	8		22 000	370	°17.6	° 88.0	96.5	94.6	109.1	108.8	52.0	20.9	587.5	74.25	285.75	1.51	No	Data		8 580	16.8	1 590		
14	Penna. #28	9		24 400	325	°12.5	64.5	81.9	69.5	81.6	73.6	79.4	10.2	473.2	74.25	223.00	1.68	16	160.	.50	5 420	13.3	1 271	.415	1.20
15	" #28	10		28 000	400	°18.6	98.4	111.3	95.1	120.4	108.2	45.5	23.8	621.3	83.70	307.37	1.54	21	225.	.54	7 140	14.3	1 554	.476	1.13
16	" #28	10		27 600	360	°15.0	° 75.0	94.2	82.4	83.5	85.4	45.7	18.6	499.8	74.25	254.18	1.58	16	160.	.50	5 800	13.0	1 382	.513	0.98
	Average Hot Air Inst.	7		17 256	302	13.3	65.7	75.5	75.1	79.7	74.0	40.9	18.1	435.7	68.40	210.29	1.61	12	130.	.50	8 676	19.6	1 440	.549	0.95
17	Hot Water Conv.	8	270	16 650	450	°17.5	98.0	100.1	68.2	110.5	90.5	67.2	32.1	584.1	93.15	303.43	1.62	12	120.	.50	11 240	27.0	1 296	.709	0.71
18	" " "	7	315	13 330	400	°21.6	117.4	121.7	138.5	98.0	115.8	69.9	36.7	719.6	83.70	342.76	1.48	20	200.	.50	17 300	30.0	1 799	.579	0.87
19	" " "	6	350	15 000	210	°13.8	79.5	96.7	85.7	69.9	63.1	33.9	19.0	461.6	45.90	212.08	1.43	16	160.	.50	9 880	14.0	2 198	.463	1.08
20	" " "	7	475	13 000	320	°18.0	° 90.2	96.2	84.0	93.0	108.9	66.9	43.8	601.0	64.80	281.16	1.46	22	200.	.48	14 820	24.6	1 880	.470	1.02
21	" " "	8	585	24 500	450	°24.0	122.9	118.3	118.3	133.6	142.7	93.3	47.6	800.7	93.15	381.40	1.48	16	170.	.48	10 500	18.4	1 780	.730	0.66
22	" " "	8	225	14 500	300	°12.9	68.2	65.8	60.6	78.6	77.8	45.2	22.1	431.2	64.80	220.03	1.59	11	110.	.50	9 550	20.3	1 437	.630	0.79
23	" " "	8	--	25 500	400	°23.0	°115.0	112.8	143.5	139.2	129.9	67.2	36.8	767.4	83.70	359.96	1.46	13	200.	.59	9 650	15.7	1 918	.730	0.81
24	" " "	7	787	28 400	500	°22.2	132.7	137.1	118.2	120.0	113.5	67.5	30.1	741.3	102.60	369.47	1.55	No	Data		8 375	17.6	1 483		
25	" " "	8	554	19 300	360	°13.5	78.7	75.7	69.4	101.8	56.9	39.3	13.6	448.9	74.25	235.85	1.64	20	135.	.40	7 460	18.6	1 244	.425	0.94
26	" " "	10	666	19 000	375	°20.5	106.8	152.0	119.4	130.3	92.3	41.0	20.4	682.7	83.70	329.47	1.50	No	Data		11 500	19.7	1 820		
27	" " "	10	725	28 500	450	°21.6	°108.0	115.8	121.2	123.1	126.4	70.5	35.2	721.8	93.15	353 00	1.52	No	Data		8 120	15.8	1 604		
28	" " "	9	852	26 100	500	°24.0	120.8	131.1	134.0	147.3	145.4	69.4	32.3	804.3	102.60	392.15	1.52	20	198.	.50	9 850	19.1	1 608	.645	0.78
29	Vapor "	10	917	51 350	540	°26.2	°131.0	130.2	137.5	144.8	149.8	100.3	53.1	872.9	112.05	426.29	1.52	No	Data		5 500	10.5	1 625		
30	" "	10	935	40 000	770	°32.2	133.6	172.8	175.1	194.2	172.0	118.1	61.0	1 059.0	149.85	531.09	1.56	20	240.	.50	8 500	19.3	1 374	.710	0.70
31	Steam "	12	700	36 600	540	°22.0	°109.8	135.0	125.0	103.8	120.7	73.3	42.8	734.4	112.05	375.71	1.60	No	Data		6 420	15.2	1 357		
32	" "	18	645	34 000	600	°34.9	°174.0	189.4	217.5	189.5	169.9	99.1	30.2	1 104.5	121.50	519.12	1.46	30	300.	.50	10 450	17.7	1 841	.592	0.85
	Average Conversion	9	557	23 233	448	21.7	111.7	121.9	119.7	123.6	117.2	70.1	34.8	720.8	92.50	352.07	1.52	17	169.	.49	9 945	19.0	1 642	.608	0.84
33	Bryant	6	451	14 400	280	°13.3	° 66.6	69.7	78.4	91.2	61.3	44.4	18.9	443.8	64.80	224.57	1.58	9	125.	.55	9 900	19.4	1 584	.633	0.87
34	"	7	533	12 450	240	°13.5	81.5	78.1	80.9	68.1	69.1	40.0	18.2	449.4	55.35	217.13	1.50	No	Data		11 570	19.3	1 870		
35	"	12	880	38 800	720	16.7	140.6	196.0	167.9	189.4	172.1	89.6	65.8	1 038.1	140.40	514.12	1.54	No	Data		8 560	18.5	1 440		
36	Peerless	15	1 170	47 000	600	°35.4	°176.8	188.5	199.1	208.8	214.5	111.1	44.3	1 178.5	121.50	545.76	1.45	35	280.	.47	8 040	12.7	1 951	.637	0.74
	Average Gas Inst.	10	758	28 165	460	19.7	116.4	144.1	131.5	139.3	129.2	71.2	36.8	777.4	95.51	375.39	1.52	22	203.	.51	9 517	17.5	1 711	.635	0.81
	Average of all Inst.	9	669	21 124	384	17.8	91.7	102.5	101.2	105.8	99.3	57.2	27.6	600.4	80.55	296.08	1.56	16	158.	.50	9 611	19.1	1 559	.579	0.89

° indicates consumption calculated on a temperature basis.

AVERAGE MONTHLY TEMPERATURES

Season	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Average
1918 - 1919	58.1	54.6	36.6	30.6	34.2	31.1	40.8	49.1	57.8	43.65
1919 - 1920	64.4	46.4	34.6	33.0	36.0	32.6	37.8	38.8	57.0	42.28
1920 - 1921	62.5	52.2	36.7	31.5	33.8	37.0	45.0	45.2	57.5	43.48
1921 - 1922	63.9	56.0	43.7	35.4	27.7	31.4	40.3	45.2	57.7	44.58
1922 - 1923	65.8	52.8	37.2	35.1	37.9	28.2	33.9	46.6	56.1	43.73

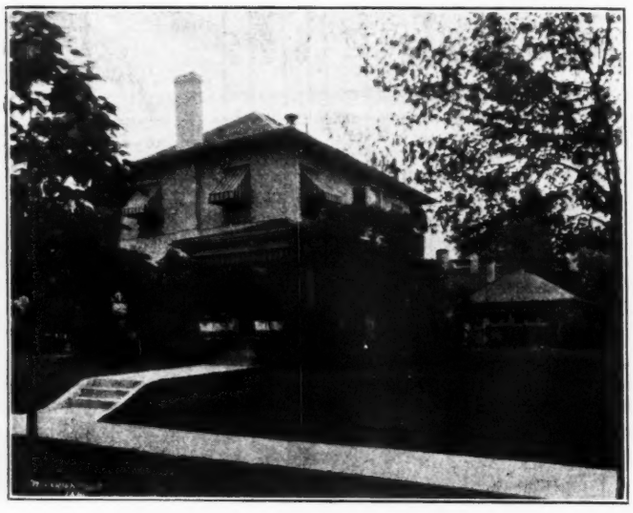


Fig. 9—Typical Denver Residence Heated by Gas.

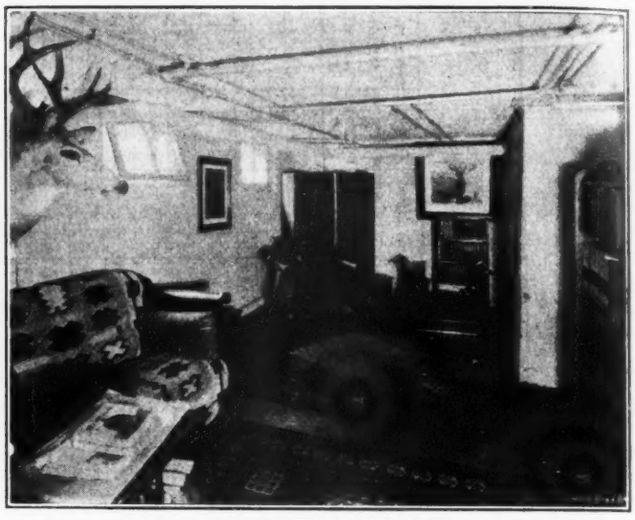


Fig. 10—Renovated Coal Bin in Gas-Heated Denver Residence.

heat regulators were installed at a cost to the customer of from $80.00 to $105.00.

The best condition for both the customer and the company is to have a low demand and long heating period. The thermostats tended to give this, since they were set to turn on the gas early and keep a constant temperature throughout the day.

ECONOMIC RESULTS OBTAINED.

A summary of house-heating data, comprising 36 representative installations, of which there were 16 gas-designed warm-air furnaces, 16 conversions of coal-fired boilers, and 4 gas-designed boilers, is shown in Table 1. In order to make proper comparisons, the values shown cover heating only. Separate meters were set in the fuel runs to the heating burners and demands and consumptions were separated from the other domestic appliances.

The demands given in the table were determined by actual test after the installation was adjusted and in use. It will be noted also in this table that many of the consumptions for the earlier months were calculated to give complete data for the season. This was necessary since there were an insufficient number in operation at that time to give proper comparative data on the various types of installations covering the entire season. These calculated values were based on the average monthly temperatures and cover such a small part of the total consumption that the error introduced is negligible.

The "readiness-to-serve" charge shown here covers the customer and demand charge for the twelve months. The cost per 1,000,000 B. T. U. of gas used is estimated on the basis of a heating value of 400 B. T. U. per cubic foot standard conditions, 30 in. hg., 60° F.

The amounts and cost of the coal given were obtained from the customer, and since it was necessary in the majority of instances to depend upon memory, some error, no doubt, has been introduced in these figures. It was also impossible to ascertain the exact kind of coal used, and hence the B. T. U. content had to be calculated from the cost and the heating values of Colorado coals listed on the market at those prices. The total cost of coal shown is the cost in the bin, ready for use, but not including the removal of ashes and janitor service.

The demand per 1000 cu. ft. contents checks very closely for the three classes of installation when the elements determining demand are taken into consideration. None of the warm-air furnaces takes a demand lower than 200 cu. ft. per hour, and the smaller-size furnace will take care of buildings up to 9000 cu. ft; consequently, small houses have a large ratio of demand to cubical contents. In conversion jobs, orifices smaller than 3/16 in. are not advisable, and since the coal-fired boilers, as a rule, are larger than needed to heat the home, the number of burners to give best results is greater than necessary to burn the required

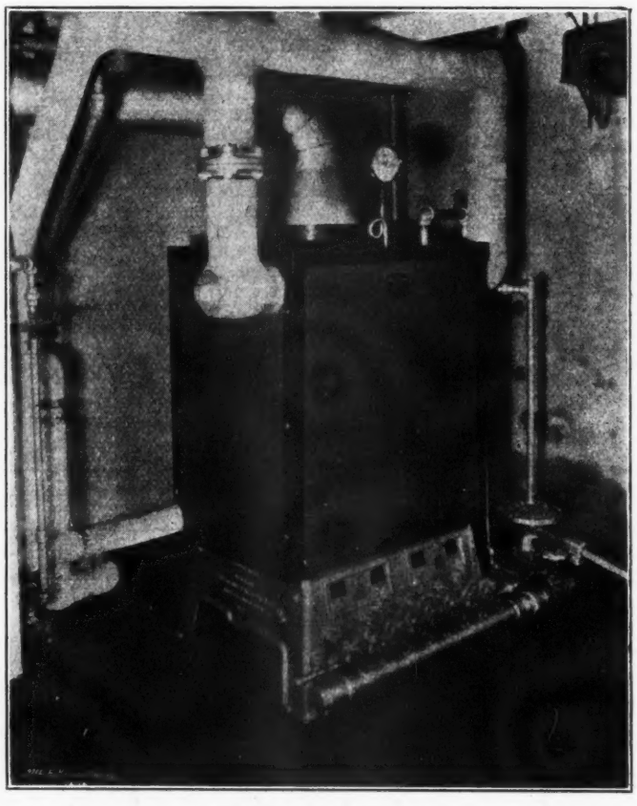


Fig. 11—Gas-fired Boiler in Denver Home, Illustrated Above.

amount of gas. Thus the demand is higher and the heating period shorter than in gas-designed equipment. There were also a few customers who desired a quick response from the heating system and were more concerned with service and convenience than in careful control and cost of operation. In these cases abnormal demands were permitted.

The B. T. U. fired, per cubic foot of contents per season, was calculated from the total B. T. U. input, divided by the measured cubical contents. The average of the three classes, warm-air furnaces 8676, conversions 9945 and gas boilers 9611, are in the order naturally expected. The wide discrepancies among individuals of the same class can be assigned to a number of causes. To analyze the situation, the condition of the house must be known. Another important factor is the human element. The number and ages of occupants, their personal habits and social activities, have an important bearing on the heating operation. The ventilation is very important, and the fact that all of the house is used, or whether certain rooms are shut off from the heat a greater share of the time.

The ratio of B. T. U. fired, gas to coal, gives a good idea of the actual utilization of heat from the two fuels. Warm-air furnaces give the lowest ratio and gas-fired boilers the highest. However, only two values could be procured for the latter, so the figures cannot be taken as an exact indication.

COMPARISON OF HEATING COSTS WITH COAL AND GAS.

The cost of heating with gas averages $1.56 per 1,000,000 B. T. U. input, while the cost of heating with coal was 50 cents per 1,000,000 B. T. U. input. However, when placed on the same basis of actual heat utilized, the cost of coal replacing 1,000,000 B. T. U. of gas averaged 95 cents for warm-air furnaces, 84 cents for conversions, and 81 cents for gas boilers, or a general average of 89 cents for coal against $1.56 for gas.

In calculating the heating cost with coal, no charges for removal of ashes or janitor service have been considered. In some cases, where a fireman was employed, the actual cash cost of heating the home, per season, with gas has been very close to the costs with coal. There are a number of intangible savings resulting from the use of gas, which can be properly considered, such as cleanliness, economy of space, ease of control and constant temperature, with resultant better health conditions.

The hour's use of demand, per season, is found by dividing the total consumption by the demand. The average for the warm-air furnaces was 1440 hours out of the total 5856 in the season, while that of the conversions was 1642 hours, and the gas-designed boilers 1711 hours, with an average for the 36 installations of 1559. This gives an annual load factor of 17.8%.

Some of the more important problems which have confronted us during the past season, are those of demand, temperature-control apparatus, the selection of a suitable warm-air furnace for local conditions, and an efficient method for conversion of water and steam boilers.

Next winter, we expect to install demand limiting meters which may permit the demand to be reduced, particularly for those customers having a large demand in proportion to their consumption. Just how far this can be carried will be different in different cases.

EFFECT OF TEMPERATURE CONTROL IN COMPUTING THE PEAK DEMANDS ON MAINS.

The control of installations has a definite effect in computing the peak demands on mains. Approximately 90% of the heating systems are thermostatically controlled, and when the temperature drops to the predetermined point, the gas is turned full on. When the temperature is raised the desired number of degrees, the gas is turned completely off. Quick-acting valves with positive action are used. This means that, at all times during the heating season, the demand is either maximum or zero. It is estimated that, in the coldest period of a severe winter the house-heating appliances will average twenty hours daily operation, which requires a distribution system adequate to supply at least 85% of the summation of the individual peak demands. Thermostatic control gives a reasonable diversity of demand, especially in milder weather. Manual control, permitting partial opening and closing of valves, may be advantageous in that a greater diversity would result, although the houses are permitted to become cold at night, with a resultant heavy load coincident with the domestic breakfast peak.

PROBLEMS CONNECTED WITH THE USE OF WARM-AIR FURNACES.

The problems confronting us on the warm-air furnaces are the lasting qualities and the thermal capacity of the material used. From experience gained by other companies, and from an analysis of our own peculiar local conditions, we have decided that an all cast-iron furnace will be the one to best meet our requirements.

It was necessary, for the rapid introduction of gas house-heating, to keep the first cost of equipment as low as possible. In order to do this, the present coal equipment had to be used, and suitable gas burners and auxiliary equipment inserted. This proved a failure on warm-air furnaces, but after considerable experimental work had been done along this line, an efficient method for conversion of water and steam boilers was worked out. This made it possible for us to put 92 customers on the line during the past season, of which only seven have been taken out, due principally to the factor of the human element.

The wide range of customers using gas heating is best illustrated by pictures of representative installations. The variety of use to which old coal rooms are put is interesting. The majority of people have their basements cleaned and decorated throughout, as soon as the heating system is installed.

Looking the Recent Trend in the Ventilation Field in the Face

Pros and Cons of the Agitation for Smaller Units, With Special Reference to the Unit Ventilator Idea

By Samuel R. Lewis
Consulting Engineer

RECENT developments in the heating and ventilating field seem to indicate a decided movement away from the old duct systems. The public seems to demand something different. Attention is arrested especially by the report of the New York State Commission on Ventilation and by the adoption of unit ventilators by the New York City Board of Education.

Is this demand for something different based upon revolutionary engineering discoveries concerning failure of the older arrangements and success of the new arrangements? Or is it an artificial demand due to selling pressure behind the proprietary new arrangements, contrasted with old arrangements which, being non-proprietary, have become stale through familiarity?

A discovery of an epoch-making and revolutionary nature in engineering is a very rare event. There are, however, very few products of human endeavor by which humans may not profit, by copying or avoiding. Any one of us can cast up a long list of inventions in heating and ventilating each of which, acclaimed for a time as a world-beater, soon passed into deserved oblivion.

Smaller cities and inexperienced school boards are the great tryers-out of most of the new ideas in schoolhouse ventilation. Seldom having unbiased or experienced heating engineers and often having inexperienced or mercenary advisors, country school boards have always been the prey of salesmen of "systems."

THE FIRST UNIT VENTILATORS.

In its beginning the unit ventilator was a very crude combination of easily procurable commercial units and its production and adoption involved good manufacturing and engineering principles.

Interestingly enough, the ventilating units when installed nearly always made friends. The ventilators were big, ugly contrivances placed with little regard to convenience or appearance in the outer aisles of classrooms. They were noisy and dirty, and yet people liked them. The occupants felt better about ventilation if they could feel the air blasting in their faces.

So anxious to sell "units" were the promoters that much good engineering lore was ignored. For instance, in a basement gymnasium, half below ground, they would hang a number of ventilating units, like sore thumbs, along otherwise beautiful walls. They ignored the desirability of exhaust ventilation for places where odors originate. They thought corridors didn't need fresh air.

So slow is human nature in its adoption of any new thing, even though that new thing may be excellent, that it seemed to be necessary for the unit ventilator manufacturers to enter the contracting field and to sell systems, instead of units.

WHAT A UNIT VENTILATOR ACCOMPLISHES

What does a unit ventilator accomplish which surpasses the results we obtain from a central system of ventilation?

It does not appear that air which has been warmed and conditioned by such a device in the class-room itself is especially different for human contact than air which has been warmed and conditioned by a similar device in an adjoining room.

As far as the air conditions within the room itself are concerned, there is a decided advantage in the point of entry,—a vertical current of air at the line of the window sill. This point of entry promotes a favorable primary since it tends to whirl the entire room air content, gives excellent diffusion of the fresh air.

It is claimed for the unit ventilator, taking its air directly from the window or wall below the window, that it is more cleanly than duct systems. Some well-cared-for units in buildings favorably located show cleaner rooms than some central duct systems in dusty neighborhoods. It is not the writer's experience that unit ventilators are particularly effective as air washers and no unit yet devised is clean, unless it is kept so by daily attention. Central duct systems can be arranged for as easy cleaning, with equal attention.

Nothing in recent years has created such a stir in ventilating circles as the findings of the New York State Commission on Ventilation in favor of the open window and the adoption by the New York City Board of Education of unit ventilators. Whatever one may think of the merits of either action, the effects are bound to be far-reaching and certainly call for the most careful consideration by those engaged in this field. The open-window idea has been discussed so often in these columns that it is not necessary to pursue the subject further, rather resting on the advice offered at a recent meeting of heating engineers that the proponents of the open window be permitted to put their ideas into practice to such an extent as will decide once and for all the limitations of this method.

In the case of unit ventilators, however, the situation is a little different. Not only have they been adopted as standard practice by the New York City Board of Education, but their use has been arranged for in such a representative building as the new Times Annex, New York. It is important, therefore, that heating and ventilating engineers familiarize themselves not only with their characteristics but with the arguments, pro and con, regarding their adaptability. The views expressed in the accompanying article are those of an engineer who has had long contact with both central duct and unit ventilating systems.

FACTORS BEARING ON THE QUESTION

The unit ventilator is apt to be much more noisy than the central duct system. Maintenance of the unit ventilator is reported to be much higher, due to the large number of small bearings to be kept oiled, and to the larger total area of metal subject to corrosion. First cost, for a large building, for unit ventilators, involving complicated piping and electric wiring, is nearly always higher than for a central duct system.

The space occupied in buildings by unit ventilators is the most expensive and valuable space there is, along the window side.

A unit ventilating plant for a large school is of great advantage over a central duct system if there is need to occupy different departments at different times. Intelligent design of a central duct system, with separate apparatus for various departments, will, nevertheless, usually accomplish the same desirable purpose, often at less cost than that of a single apparatus and nearly always at much less cost than that of the many unit ventilators otherwise required.

It is very easy to arrange class-rooms with points of air entry which give all the advantage of distribution inherent in unit ventilators, and this has been done by some designers for years. Air may be carried to outside walls between the joists of concrete buildings with the greatest facility and may be introduced at the window sills without obstructing the aisles.

WHY "ADOPT" ANY METHOD OF VENTILATION?

The predominant reflection with reference to the adoption of unit ventilators by the New York City Board of Education is wonder that any such adoption should have been necessary. Do we hear that a board of education has adopted some special kind of stone or roofing? Doubtless it is advised by its architect who suggests the kind of stone and the kind of roof which will be most fitting for each design and location. The architect is seldom limited to any specific material. He is rarely told, for instance, that all buildings must be built of stone.

It may be that in certain metropolitan schools, on high-priced land, it will be better and less costly to use unit ventilators for class rooms. In such buildings, many stories high, the conventional flues from basement supply-fans are exceedingly troublesome, taking up much valuable space. Under such conditions the advisors of any board of education should be able to specify unit ventilators without requiring circumscribing orders so to do.

Any competent engineer should use the tools and devices of his profession to the best advantage of his client. In the writer's own experience, he has found cases where unit ventilators have filled the requirements in a highly satisfactory manner, and other cases where central supply systems have proved preferable. Why not use that which best serves?

TREND TOWARD SMALLER UNITS IN ALL HEATING AND VENTILATING PRACTICE

There is a decided trend in all heating and ventilating practice towards smaller units, shorter ducts and more of them. A given volume of air or power does not cost much more as to investment and operation, when handled by ten fans and electric motors, than when handled by one fan and one electric motor. It is easy to save far more in the reduction of costs of ducts than in the increase in the cost of apparatus. I do not think this trend towards smaller units means a revolution in school-building ventilation. It is rather a normal and logical development following universal electric service.

We must not lose sight of the tremendous value of unit ventilators for old buildings and small installations where they can often be installed at less cost than that of any other arrangement giving equal service.

Any good engineer will devise for any building which he is equipping, a ventilating plant using unit ventilators, central-duct supply systems, and exhaust systems, as the conditions may indicate, and few buildings will be found in which an intelligent combination of all these types may not be used to advantage.

Coal Consumption in New York State Public Institutions

In connection with the measures taken by the New York State public institutions to meet the rising fuel costs by proper supervision and study, which were described in THE HEATING AND VENTILATING MAGAZINE for September, detailed figures were given for various institutions covering a period of years from 1917 to 1921. These figures were itemized as "pounds," whereas, of course, they represented tons of coal consumed, as shown on the accompanying table.

HOSPITALS REPORTING ON LOG SHEETS

INSTITUTION	1917-1918		1918-1919		1919-1920		1920-1921	
	AVE. DAILY CENSUS	COAL CONSUMED TONS	AVE. DAILY CENSUS	COAL CONSUMED TONS	AVE. DAILY CENSUS	COAL CONSUMED TONS	AVE DAILY CENSUS	COAL CONSUMED TONS
BINGHAMTON	2712	23,740	2673	13,832	2700	18,262	2644	[a]17,541
BROOKLYN	863	4,306	930	4,974	1090	5,684	1189	5,788
BUFFALO	2194	11,802	2202	12,640	2163	12,126	2176	[a]12,447
CENTRAL ISLIP	4951	35,530	5155	30,589	5330	33,435	5387	29,070
GOWANDA	1284	11,431	1278	12,095	1250	[a]10,291	1234	[a]9,000
HUDSON RIVER	3432	24,879	3387	21,346	3423	[a]24,612	3451	[a]20,797
MANHATTAN	5083	29,810	5352	39,384	5427	24,790	5820	21,956
MIDDLETOWN	2203	8,269	2125	12,759	2091	[a]9,022	2083	9,746
ROCHESTER	1593	7,516	1529	8,117	1556	8,224	1606	7435
ST. LAWRENCE	2260	17,268	2230	16,043	2215	[a]15,307	2247	[a]14,800
UTICA	1686	7,938	1651	8,924	1662	7,216	1659	7,789
TOTALS	28261	182,489	28512	180,703	28907	168,969	29496	156,369

NOTES: *Coal figures to the right of heavy line indicate years in which the hospitals have reported on power plant log sheets which have been checked by the department of agriculture*

a - Weight corrected by annual inventory

Kings Park is not tabulated on account of lack of complete data

HOSPITALS NOT REPORTING ON LOG SHEETS

INSTITUTION	1917-1918		1918-1919		1919-1920		1920-1921	
	AVE. DAILY CENSUS	COAL CONSUMED TONS	AVE DAILY CENSUS	COAL CONSUMED TONS	AVE. DAILY CENSUS	COAL CONSUMED TONS	AVE DAILY CENSUS	COAL CONSUMED TONS
WILLARD	2345	11,802	2379	14,148	2427	13,249	2389	13,512

Coal Consumption in New York State Hospitals, 1917 to 1921.

Critical Velocity of Steam with Counter-Flowing Condensate

Practical Data Secured Through Recent Tests for Solving Problems Where the Flow of Condensation is Counter to the Steam Flow*

By William A. Pearl and Eri B. Parker

IN ANY installation, such as a one-pipe heating system or any other arrangement wherein it is desirable to carry the condensate back through the same pipe, it would be advantageous to know the critical velocity of the steam. By critical velocity is meant the maximum flow of steam that can be maintained without hindering the continuous return of the condensate.

The lack of accurate information on this subject has caused such installations to be based almost entirely upon the judgment and the experience of the designer. It can easily be seen that such practice might lead to extravagant habits in design in order to insure the proper working, as well as to protect the designers' reputation.

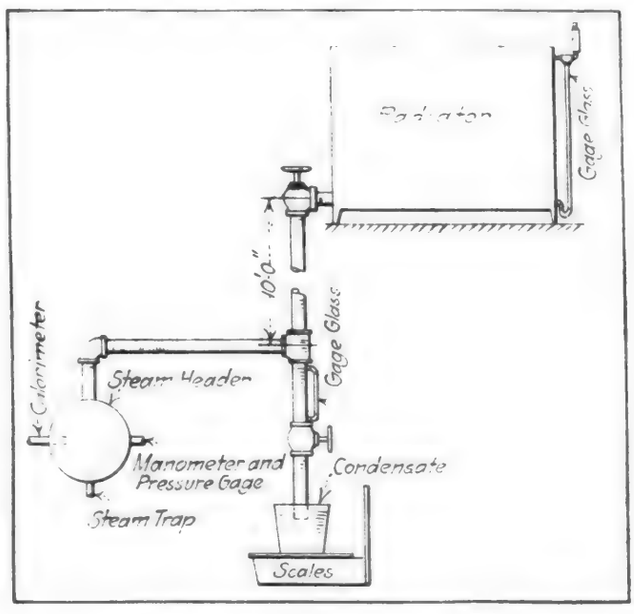


Fig. 1—Arrangement for Vertical Riser.

Authors of text-books on the subject of heating have been unable to give accurate data on this phase of the work, but have contented themselves with giving what they considered safe practice.

The object of the research here described is to study the conditions existing in one-pipe systems and to arrive at some conclusions that will be useful in any designs requiring a counter-flowing condensate.

When the experiment here described was started, state the authors, no material on the subject was found. During the process of the work two articles, briefly stating the results of similar experiments covering a part of this work, were published. One article, written by F. E. Giesecke, Head of the Research Division of the University of Texas, was presented at the semi-annual meeting of the American Society of Heating and Ventilating Engineers, at Buffalo-Detroit, in June, 1922. The other tests were carried out at the laboratories of Warren Webster & Company and the results appeared in the work on "Steam Heating," published by that company.

METHOD AND APPARATUS

The method of approaching this problem was to set up a typical single-pipe heating installation and to observe the effect of varying conditions of velocity, pipe size, slope and pressure upon the uniform return of the condensate. Steam of a known pressure and uniform quality was conducted through a pipe of known size and pitch to a radiator of suitable size and the counter flow of the condensate observed under varying conditions of velocity.

By referring to Figs. 1 and 2 the following description of apparatus used may be more clearly understood.

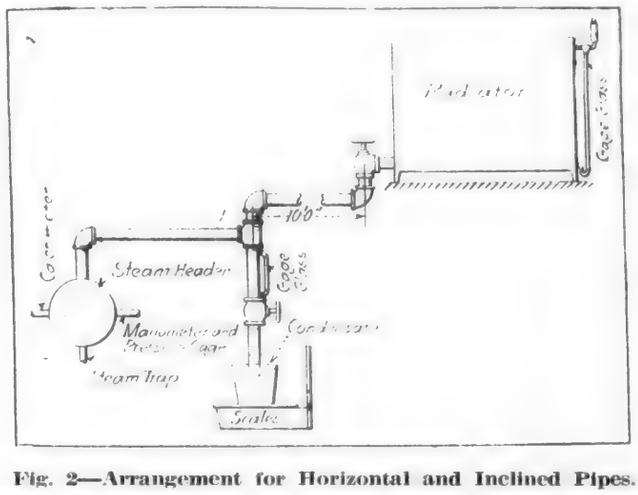


Fig. 2—Arrangement for Horizontal and Inclined Pipes.

Steam for the experiment was led into a header that was made up of a 4-ft. section of 6-in. pipe. The header was provided with a manometer, pressure gauge, steam trap, and suitable connections for a calorimeter. Dry, saturated steam was led from the top of the header to an ordinary radiator. Fig. 1 shows the arrangement of pipes for the tests on vertical risers. The riser in each case was a 10-ft. length of pipe, with standard radiator valve and connections. The radiator was fitted with a water glass and air valve as shown. Fig. 2 shows the connections for horizontal pipes. The slope was varied by raising the radiator.

The radiation was varied by a number of different methods, by use of coverings, by use of a variable-

* From a bulletin (Engineering Bulletin No. 13), issued by the Engineering Experiment Station of the State College of Washington.

speed fan, and by the use of water.

THE DATA SECURED.

The first data were taken with a vertical riser and a standard valve of the same nominal size. Readings were taken for each pipe size under pressures of considerable range.

Tests of ten minutes' duration were run during which time the pressure and rate of condensation was held constant. Working in this manner, the rate of condensation was gradually increased until a point was reached where the condensation did not all return in the pipe. The maximum amount returned was recorded.

The maximum amount of water returned was determined by carefully weighing the returned condensate for each 10-min. test. Careful observation was made in each case to determine whether or not any water was held up. It was found that as the radiation was increased for each 10-min. period, the condensate return increased in proportion up to a certain point at which it showed a marked decrease. In each case, at this point, water was found to have been held up in the radiator, which showed that the critical velocity had been exceeded.

Tests were run in this manner on vertical, inclined, and horizontal pipes, ranging in size from ¾ in. to 2 in. inclusive, and under pressures ranging from 1 to 6 lbs.

The first thing of importance noted was that the critical velocity was practically independent of the pressure used. This is shown in Table 1, in which it may be noted that the maximum condensate returned in each 10-min. period was practically constant.

This condition being established, no further reference to pressure will be made in the following discussion.

In making calculations for critical velocities, Table 2 was made up. The values for maximum condensate returned, as shown in this table, are the average values for each pipe size as shown in Table 1.

During the test it was observed that the maximum condensate was not necessarily governed by the pipe size, but rather by the smallest cross-section in the line through which the condensate must flow. As a result of this, when a standard valve for the pipe used was installed, it became the governing factor because of the smaller throat area.

With the elimination of this condition in view, a series of tests was run in which the valve used was one size larger than the pipe. In this case the pipe became the limiting factor instead of the valve. (See Table 3).

Because of this condition where valves of the same nominal size as the pipe are used, two different critical velocities may be calculated. The value obtained by

TABLE 1—CRITICAL VALUES

Pipe Size, In. Diam.	Pressure, Lbs.	Condensate Return in 10 Minutes, Lbs. Slope ½ In. in 10 Ft. Vertical	Slope 6 In. in 10 Ft.	
¾	1	.....	0.937	1.562
¾	2	1.437	1.0	.....
¾	3	.....	0.875	1.312
¾	4	1.5	0.937	.....
¾	5	1.375	0.937	1.312
¾	6	1.325	1.0	1.5
1	1	3.312	2.0	.....
1	2	3.218	2.215	3.687
1	3	.....	1.887	.....
1	4	.....	1.875	.....
1	5	3.187	.....	.....
1	6	3.375	1.812	.....
1¼	1	5.687	4.437	5.620
1¼	2	5.250	4.5	6.125
1¼	3	5.0	5.0	5.625
1¼	4	5.375	4.750	5.625
1¼	5	5.437	4.687	6.0
1¼	6	5.750	.....	5.875

TABLE 2—VELOCITY IN PIPES AND VALVES

	Nominal Pipe Size	Nominal Valve Size	Actual Pipe Size	Actual Diam. of Valve Throat	Actual Pipe Area	Actual Valve Area	Pounds Per Minute	Volume Per Minute**	Velocity Ft. per Minute in Pipe*	Velocity in Valve Ft. per Minute	B T U Per Min ***
Slope ½" in 10 Feet	¾ inch	¾ inch	13-16 inch	¾ inch	.5184	.442	.0948	2.13	592	694	92
	1 inch	1 inch	1 3-64 inch	1 inch	.8600	.785	.1979	4.45	745	816	192
	1¼ inch	1¼ inch	1 3-8 inch	1¼ inch	1.485	1.227	.4604	10.33	1002	1213	448
Slope 1½" in 10 Feet	¾ inch	¾ inch	13-16 inch	¾ inch	.5184	.442	.140	3.15	875	1025	136
	1 inch	1 inch	1 3-64 inch	1 inch	.8600	.785	340	7.65	1282	1405	330
	1¼ inch	1¼ inch	1 3-8 inch	1¼ inch	1.485	1.227	.5875	13.22	1283	1552	572
Slope 6" in 10 Feet	¾ inch	¾ inch	13-16 inch	¾ inch	.5184	.442	.1448	3.255	903	1062	141
	1 inch	1 inch	1 3-64 inch	1 inch	.8600	.785	.3687	8 30	1390	1522	357
	1¼ inch	1¼ inch	1 3-8 inch	1¼ inch	1.485	1.227	.5812	13 08	1270	1536	566
Slope 12" in 10 Feet	¾ inch	¾ inch	13-16 inch	¾ inch	.5184	.442	.1562	3.52	978	1145	152
	1 inch	1 inch	1 3-64 inch	1 inch	.8600	.785	.3625	8.15	1367	1495	353
	1¼ inch	1¼ inch	1 3-8 inch	1¼ inch	1.485	1.227	6000	13.50	1310	1585	584
	1½ inch	1½ inch	1 39-64 inch	1½ inch	2.04	1.767	.8625	19.41	1375	1590	836
	2 inch	2 inch	2 1-16 inch	2 inch	3.341	3.141	1 525	34.30	1477	1573	1485
Slope 54" in 10 Feet	¾ inch	¾ inch	13-16 inch	¾ inch	5184	.442	.1437	3.233	897	1052	139
Vertical	¾ inch	¾ inch	13-16 inch	¾ inch	.5184	.442	.1416	3 1825	887	1038	137
	1 inch	1 inch	1 3-64 inch	1 inch	.8600	.785	.3313	7.45	1248	1370	322
	1¼ inch	1¼ inch	1 3-8 inch	1¼ inch	1.485	1.227	.5433	12.22	1185	1438	528

* This is not a true critical value for Pipe Velocity since the limit is in the valve.
** Specific volume taken as 22.5 cu. ft. per lb.
*** B T U per lb taken as 970.

using the area of the pipe will be a false value and should not be considered, since the velocity through the valve is the velocity that actually limits the flow.

By using a valve one size larger than the pipe, the true critical velocity in the pipe was determined and these values are shown in Table 3.

Although the values shown in Table 1 vary somewhat, apparently no relation exists between pressure and critical velocity. These values are single readings and the variation is apparently due to irregularity of flow of the condensate at the critical point and to the short duration of each test.

As a result of this unavoidable condition the values used in the final calculations and charts are the averages of a number of readings in each case. Approximately 200 readings were taken on each pipe size.

It is interesting to compare the critical velocity found in the pipes, as shown in Table 3, with the values for the valve in Table 2. These values compare as consistently as could be expected, considering the slight difference in size (for it will be noted from both tables that the critical velocity increases slightly with the pipe size within certain limits).

In order to further check the evidence that the critical velocity is determined by the smallest area in the line, tests were run on a 1-in. pipe, with a ¾-in. orifice in a thin metal plate inserted in the line. Tests were also run on a 1-in. pipe with a ¾-in. valve. The results of these tests are shown in Table 4.

A comparison of these values shows that although the critical velocity in the line is governed by its smallest cross-section, if this smallest section is an orifice or valve opening, it does not have quite as much effect on the critical velocity as a longer section would have.

RESULTS

The results of these observations may be summarized as follows:

1. The critical velocity of steam in a one-pipe heating system is independent of pressure within ordinary heating ranges.

2. The critical velocity increases slightly with an increase in pipe size. This increase is greater in smaller pipe sizes and becomes practically negligible in sizes larger than 1¼-in. This is shown from values given in Table 3 and velocities through valves in Table 2.

3. Referring to Table 2, it will be seen that the critical velocity increases with an increase in slope up to 1½ in. in 10 ft. For greater slopes than this, the critical velocity shows practically no increase. For vertical risers the velocity even shows slight decrease from that of the 1½-in. slope. (See Fig. 3).

4. The standard valves as used in heating practice have an actual throat area smaller than the actual area of the pipe of the same nominal size. As a result of this condition, the capacity of the runout is limited by the valve. Data showing this comparison, with an explanation, are given in Table 5.

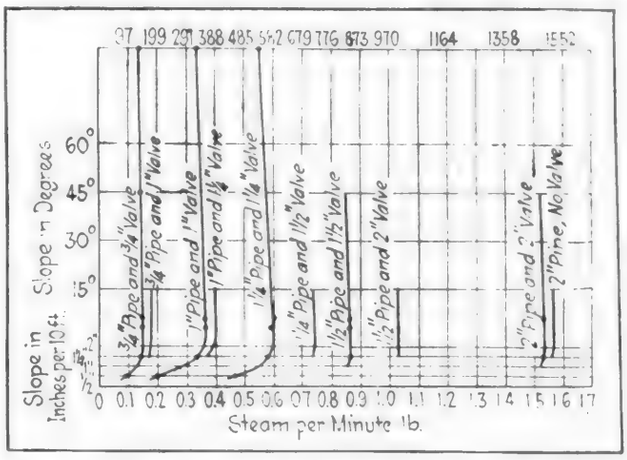

97 199 291 388 485 582 679 776 873 970 1164 1358 1552
Slope in Degrees
60°
45°
30°
15°
Slope in Inches per 10 Ft.
¾" Pipe and ¾" Valve
¾" Pipe and 1" Valve
1" Pipe and 1" Valve
1" Pipe and 1¼" Valve
1¼" Pipe and 1½" Valve
1½" Pipe and 1½" Valve
1½" Pipe and 2" Valve
2" Pipe and 2" Valve
2" Pipe, No Valve
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7
Steam per Minute lb.

Fig. 3—Capacity of Pipes at the Point of Critical Velocity.

5. As long as the critical velocity is exceeded in the runout, the amount of water held up in the radiator will continue to increase, even though a considerable head is produced. By tests it was found that by exceeding the critical velocity for a sufficient time, the radiator tends to fill with water. In connection with this, one test was run during which the critical velocity was greatly ex-

TABLE 3—CRITICAL VELOCITY IN PIPES, SLOPE 6 IN. IN 10 FT.

Nominal Size	Actual Size	Actual Area	Lbs Per Minute	Volume in Cu Feet Per Minute	Velocity Feet Per Minute	B. T. U. Per Minute
¾ inch	13-16 in.	.5184	.1687	3.80	1052.	164.
1 inch	1 3-64 in.	.860	.4000	9.02	1505.	389.
1¼ inch	1 3-8 in.	1.485	.7500	16.88	1640.	730.
1½ inch	1 39-64 in.	2.04	1.025	23.10	1630.	1000.
2 inch	2 1-16 in.	3.341	1.568	35.3	1520.	1519.

* Using a valve one size larger than pipe

TABLE 4—CRITICAL VELOCITY IN PIPES, SLOPE 6 IN. IN 10 FT.

Nominal Size	Actual Size	Actual Area	Lbs Per Minute	Volume in Cu. Feet Per Minute	Velocity Feet Per Minute	B. T. U. Per Minute
Velocity in ¾ inch pipe using 1 inch valve						
¾ inch	13-16 in	.5184	.1687	3.80	1052.	164.
Velocity in ¾ inch valve fed by ¾ inch pipe						
¾ inch	¾ -in	.44	.1448	3.26	1056.	141.
Velocity in ¾ inch valve fed by 1 inch pipe						
¾ inch	¾ -in	44	.1687	3.78	1231.	164.
Velocity in ¾ inch orifice set in 1 inch pipe						
¾ inch	.781 in	.48	.200	4.5	1350.	194.5

ceeded. The radiator completely filled with water and in this condition, even though the flow of steam was practically reduced to zero, the entire head was maintained with no return in the pipe whatever. This condition shows what happens if a pipe is greatly overloaded with radiation in a one-pipe heating system. If a pipe is slightly over-loaded with radiation (that is, if the critical velocity is slightly exceeded) the returns become intermittent, and noisy operation may result.

6. With regard to the conditions that exist when steam is turned into a cold radiator, some interesting results were obtained. Steam was turned into a cold radiator which was of proper size to give critical velocities in the pipe under normal running conditions at the existing room temperature. A standard air valve was used. The test was run until the entire radiator became hot, at the end of which time the condensation was weighed. Careful observation during the test showed that except for the first rush of steam, the critical velocity was not exceeded, and no condensate was being held up in the radiator at the end of the warming-up period. This test shows that insofar as the heating of the radiator itself is concerned, no difficulty may be expected due to excessive velocities.

TABLE 5—SLOPE 1½ IN. IN 10 FT. OR MORE.

Standard Pipe With the Same Size Valve In. Diam.	Maximum B. T. U. Per Minute	Standard Pipe With One Size Larger Valve In. Diam.	Maximum B. T. U. Per Minute	Gain By Larger Valve Per Cent.
¾	136	¾	164	20.6
1	330	1	389	17.9
1¼	575	1¼	730	27.0*
1½	836	1½	1000	19.6
2	1485	2 in. pipe no valve	1519	2.3

*This apparent excessive increase is due to the fact that a 1¼ in. pipe is 10% larger in diameter than the nominal size.

The above table shows that a substantial increase in capacity is obtained by using a valve one size larger than the nominal pipe size.

TABLE 6—COMPARISON OF EFFECT OF SLOPE ON CAPACITY OF 1¼ IN. PIPE.

Slope in 10 ft., Inches.	Maximum B. T. U. per Minute
½	448
1 ½	575
6	566
12	584
Vertical	528

In comparing the effects of slope on the capacity of a runout, it is here shown that an increase in slope from ½-in. to 1½-in. in 10 ft. gives an increase in capacity of 28.3%. From this point on, no apparent gain is shown by increasing the slope. This is shown to be true, independent of pipe size.

PRACTICAL APPLICATION

The practical applications of these observations briefly stated are:

As to Pipe Size. 1. Where noise is objectionable, the critical velocity must not be exceeded at any time.

2. Where a certain amount of noise during the heating-up period of the room is allowable, the critical velocity might be exceeded slightly and sizes chosen for the normal heating conditions. Great care must be exercised if the latter method is used or unsatisfactory results will follow.

Experiments have shown that the heat emitted by a radiator increases about 6% for each 10-degree decrease in room temperature from 70° F. As a result of this increase, if the pipe size is chosen so as to give approximate critical velocity under normal room temperatures, the critical velocity will be exceeded during the heating-up period of the room, and a noise may result. To eliminate this condition, if it is objectionable, the pipe size should be chosen to conform to maximum requirements during the heating-up period of the room. The following example will illustrate this condition:

Considering a 1¼-in. pipe, with a slope of 1½-in. in 10 ft., the critical velocity was found to be 1552 ft. per minute, which corresponds to a transmission of 575 B. T. U. per minute, or 34,500 B. T. U. per hour. Assuming conditions such that 250 B. T. U. are radiated per square foot per hour, with a room temperature of 70°, it was found that 138 sq. ft. of radiation would be allowable on the above pipe. If, however, the room temperature is dropped to 40° F., the radiation will now be increased 6% for each 10-degree difference, or 18% for the total increase. This increases our radiation per square foot from 250 to 295 B. T. U. per hour, which would give only 117 sq. ft. of radiation allowable on the 1¼-in. pipe, as compared with the 138 sq. ft. calculated for a room temperature of 70° F.

3. Since a pipe with the same nominal size valve is limited by the valve, one method of working a pipe to its limit is to install a valve one size larger than the pipe.

The accompanying table (Table 5) might be profitably studied in connection with the design of a one-pipe heating system. Table 5 shows that a substantial increase in capacity is obtained by using a valve one size larger than the nominal pipe size.

As to Slope. It is apparent that with certain types of building construction very flat slopes for horizontal runouts are hard to avoid. Since the critical velocity drops very rapidly with a slope less than 1 in. in 10 ft., flatter slopes should be avoided if possible. A lower limit might reasonably be placed at ½ in. in 10 ft.

No advantage seems to be gained by using slopes greater than 1½ in. in 10 ft.

Aerology for Amateurs and Others

The Evolution of Modern Ventilation and its Effect on Present and Future Practice

By E. Vernon Hill

Previous articles in this series are as follows: January, 1923, Historical Sketch; February, 1923, Health and Comfort Factors; March, 1923, The Manufacture and Use of Thermometers; April, 1923, Test Methods; May, 1923, Air Dust; September, 1923, Classification of Test Methods for Dust Determinations.

VII—Discussion of Test Methods for Dust Determinations

IN MAKING dust counts with the Sedgwick Rafter counting cell method, the ruled ocular of the microscope is usually adjusted to 1 sq. millimeter so that the field taken on the counting cell will be 1 cu. millimeter. Several counts are usually made over the cell and the average taken. As this average is for 1 cu. millimeter, the count must be multiplied by 1,000 to get the number of particles in the total cell which has a capacity of 1 cu. centimeter. This number must again be multiplied by the dilution of the general sample, usually 50 or 100, so that any error in the original count is multiplied by 50,000 or 100,000 in arriving at the final number of dust particles in the entire sample. In other words, an error of one dust particle, which by the way is not difficult to make, becomes an error of 50,000 or 100,000 particles in the final determination.

Where samples of dust in the air are taken by the sugar-tube method, a much greater mathematical error results. The common procedure in using the sugar tube is to dissolve the sugar containing the dust in a small amount of distilled water with the aid, usually, of a small amount of heat. This sample is made up to 500 c.c. with distilled water and 1 c.c. of this solution placed in the Sedgwick-Rafter Cell for counting. One-quarter of the field, viz., one-quarter of a square millimeter, is the basis used for counting. To arrive at the final count, therefore, the average count in one-quarter of the field must be multiplied by 4, again by 1,000, again by 22, again by 500 and divided by 2 to get the total number of particles in the sample. That

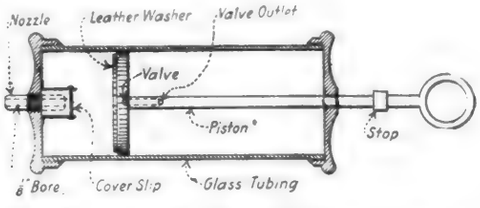


Fig. 20—First Model of Hill Dust Counter.

is, the original average count is multiplied by 22,000,000 to obtain the total.

In this procedure, an error of 1 dust particle in the original field becomes an error of 22,000,000 in the final count. The mathematical error involved in this procedure is so enormous that it sometimes entirely overshadows the entire number of dust particles in the sample. In 1921, the Bureau of Mines, where the sugar-tube method enjoys considerable favor, was supplied with six samples of dust in aqueous suspension and a request made that they report on the number of particles in each. All six samples were taken from an *original sample* differing only in the amount of dilution with clean distilled water and there should, therefore, be no difference in the number of dust particles in each. The report, however, showed an increasing number of particles with the increasing dilution in each and a curve could be plotted from the results from which the dilution could be determined, conclusive evidence to the writer that the mathematical error in determining the final count is much more important than the original field count.

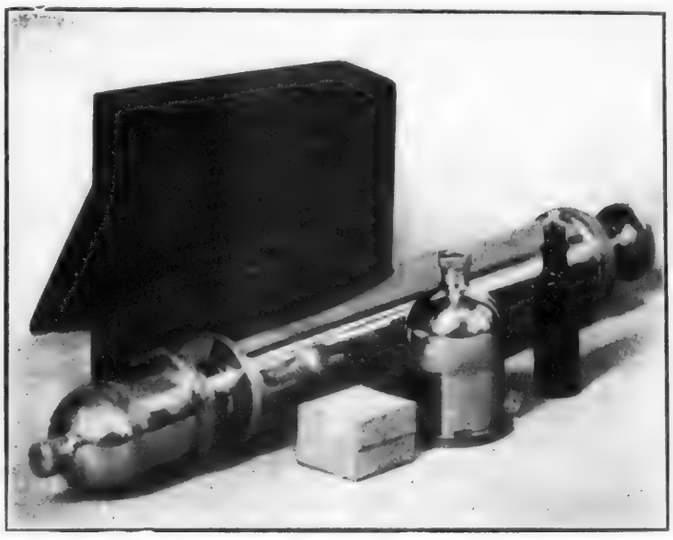


Fig. 21—Essential Parts of Hill Dust Counter.

THE HILL DUST COUNTER

To escape from the errors that are always present when dust particles are collected under water and particularly through the mathematical errors previously referred to and also to obtain an instrument that was simple in operation and portable, the writer finally designed the apparatus illustrated. It consists essentially of a metal exhaust pump having a known capacity and an air-tight capsule affixed to the nozzle of the pump. The interior of the capsule is arranged to hold a ½-in. round cover glass directly beneath the air intake nozzle of the capsule. The cover glass is smeared with an adhesive which does not readily dry out or form a surface film. When the piston of the pump is operated, air to be sampled is drawn through the intake nozzle of the capsule and thrown at a high velocity against the adhesive surface of the cover glass, the latter retaining a large proportion of the particles.

The first model of this instrument is shown in Fig. 20. We did not know from this method what proportion of the total number of particles entering the device were retained on the adhesive surface and what portion escaped. A series of interchangeable capsules were therefore made and one superimposed upon the other so that the air being sampled passed consecutively through each. By connecting in series six capsules in

Fig. 22—Hill Dust Counter Complete in Case.

this manner, practically all the dust was retained. We later found that as the reduction in the dust content was uniform two capsules could be used and an equation derived which gives the percentage of dust retained on the first. The derivation of the equation is as follows:

Let X = number of particles entering first capsule
p = percentage caught by cover slip,
A = count on first cover slip,
B = count on second cover slip.

Then $X \times p$ = number counted on first cover slip..(1)

$$X \times p = A \quad \ldots\ldots (2)$$

$X - A$ = particles entering second capsule...(3)

$(X - A) \times p$ = number counted on second cover slip.....(4)

$$(X - A) \times p = B \quad \ldots\ldots (5)$$

Dividing (2) by (5) to eliminate p:—

$$\frac{X \times p}{(X - A) \times p} = \frac{A}{B} \quad \ldots\ldots (6)$$

$$\frac{X}{(X - A)} = \frac{A}{B} \quad \ldots\ldots (7)$$

Solving this equation for X:—

$$X = \frac{A^2}{A - B} \quad \ldots\ldots$$

$$p = \frac{A}{X} \quad \ldots\ldots \text{(from equation (2)}$$

Solving with this equation, we found that for average room dust, the adhesive plate retains about 81% of the total number of particles entering the capsule. The nozzle of the capsule is of the proper size so that the dust spot on the sample falls entirely within the field of the microscope. In arriving at the total number of particles in a cubic foot of air, therefore, it is only necessary to divide the number of particles counted on the adhesive surface by the efficiency and make a correction for the quantity of air handled. As the total number of particles are actually counted, there are no errors due to applying large multiplication or dilution factors and as the particles are retained on the adhesive plate as they actually occur in the air, no error enters from the breaking up of particles into innumerable smaller ones. Furthermore, the kind and character of the dust particles themselves can be studied by this method, as they are not altered or changed in any way. The essential parts of the apparatus shown in Fig. 21 consist of a pump, two capsules, cover glasses and slides and a bottle of adhesive material. The complete instrument in the case is shown in Fig. 22.

NEW MODEL DESIGNED FOR FIELD WORK

As the original dust counter, using the superimposing capsules, is somewhat unsuitable for field work, owing to the small size of the cover glasses and the difficulty in handling the same, a new model was designed, as shown in Fig. 23. In this instrument the capsule holding the cover glass has been replaced by a larger capsule

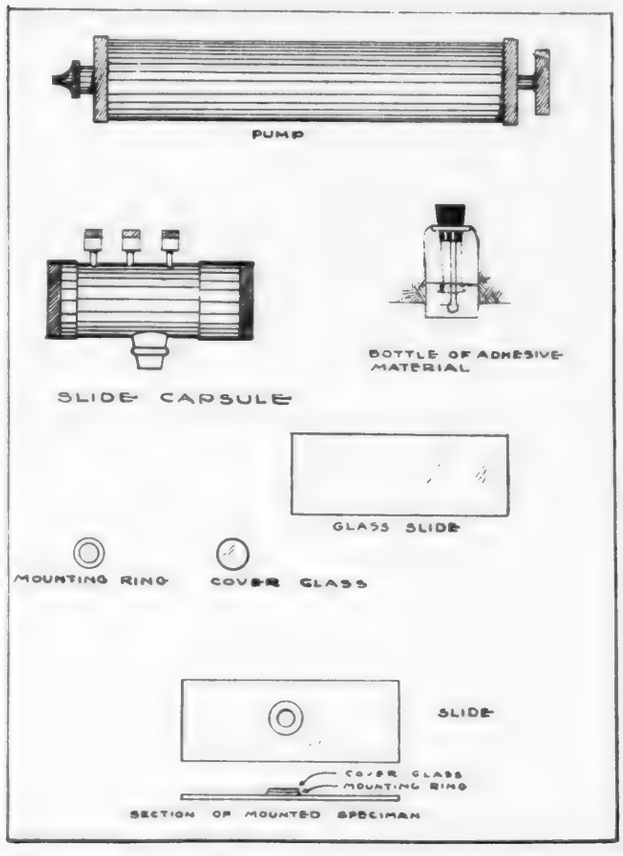


Fig. 23—New Model of Hill Dust Counter for Field Work.

which receives the glass slide instead. It is also provided with three nozzles, instead of one, so that three air samples may be taken with one loading of the apparatus. With the adhesive plate method as represented by these instruments, a much lower dust count is obtained than by any other method. The reason for this has been explained in the present article. Dust counts in school rooms where modern sanitary precautions are observed, such as oiling of floors, washing or filtering

of the air supply, etc., should give less than 10,000 particles per cubic foot. We frequently obtained counts as low as 5,000 and we set a standard in new schools of 5,000 dust particles or less.

BACTERIA

The importance of air-borne bacteria parallels to a great extent the importance of dust and what has been previously stated with regard to air dust is, to a certain extent, true of air bacteria. As a general thing when the dust content of the air is high, the bacteria content will also be high and where the dust count is low, we find a small amount of bacteria. This is not always the case, as sometimes air dust, such as ashes, soot and many mineral and inorganic dust particles, do not carry bacteria and we may have a high dust content and a relatively low bacteria content.

On the other hand, in clothing establishments, especially in industries where old material is handled or sorted, the dust content is usually high, but the bacteria content very much higher and apparently out of all proportion to the amount of dust in the air. As a usual thing, however, the dust and bacteria counts are more or less parallel.

The usual culture methods for determining air bacteria take into account only those organisms that develop in air or oxygen and these are used as representatives of the total bacteria content.

Some commentators viewing air bacteriological work from this angle are inclined to minimize the value of bacteriological determinations. There is, however, a phase to the question that should not be overlooked. Bacteriologists consider micro-organisms under two broad classifications, as being "pathogenic," that is disease-producing, and "non-pathogenic," or not disease-producing, and under the non-pathogenic heading most of the organisms are included that are cultured from the air. These include various moulds and fungi, putrefactive organisms, particularly the albus and aurius, and occasionally some streptococci.

The bacteria that do not have a specific disease-producing effect on the human body are too often considered harmless because they are of the non-pathogenic variety. It is clear that non-pathogenic does not necessarily mean harmless and the effect of constantly inhaling these organisms, especially when they come into contact with irritated or inflamed mucous surfaces or, in other cases, where a mass infection results, may be distinctly harmful either in themselves, or by paving the way for more serious infections.

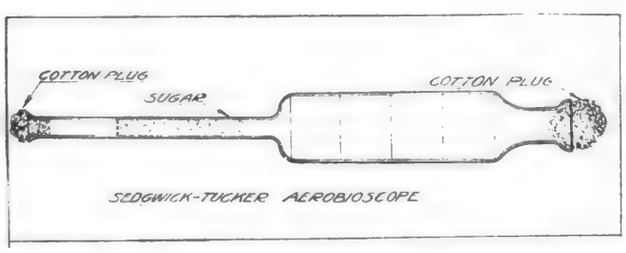


Fig. 24—The Sedgwick-Tucker Aerobioscope.

With regard to the pathogenic organisms, those that are recognized as the specific cause of certain infectious diseases, we need only say that their presence in the air causes more deaths annually than did all the bullets, shells and gas bombs of both the German and Allied armies during the late war. The great importance of air-borne infections in tuberculosis, pneumonia, meningitis and many other diseases, is gaining a wider recognition as our knowledge of these infections increases. The subject of air bacteria in its relation to the ventilation, particularly of schools, factories and public buildings, is one that in all probability will receive much more attention in the future than it has in the past.

Persons responsible for the design and operation of ventilating equipment in schools bear a serious responsibility if this important factor is overlooked.

TEST METHODS

Probably the best-known method of making quantitative determinations of bacteria in the air was devised by Esmarch and is known as the Esmarch Tube. The tube is of glass, used in varying lengths and sizes averaging about 2 in. in diameter, possible 2 ft. long.

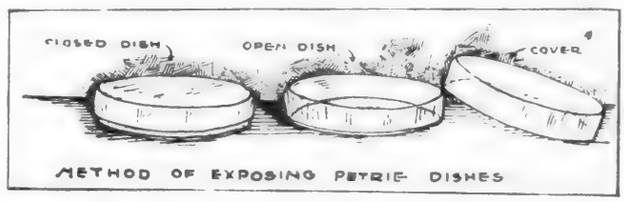


Fig. 25—Method of Exposing Plates for Air Cultures.

The tube is coated on its inside surface with nutrient agar by pouring in the agar when liquid and allowing it to cool while the tube is revolved or rolled on a level surface.

A measured quantity of air is passed through the tube, the bacteria being deposited on the agar surface. The tube is then incubated at 20° Centigrade and the colonies that develop are counted.

The Sedgwick-Tucker Aerobioscope is a modification of, or perhaps it is better to say an improvement on, the Esmarch method. It consists of a glass tube drawn out at one end, as shown in Fig. 24. The small portion of the tube contains a screen in its distal portion. The portion of the tube above the screen is filled with granulated sugar and the entire apparatus placed in a sterilizer at not over 120° Centigrade and the sugar and tube sterilized. In taking a culture of the air the tube is held in a vertical position with the large portion upward. A rubber tube is attached to the lower end and a measured quantity of air drawn through the sugar, either by means of an aspirating bottle or calibrated pump. After the sample is taken the cotton plugs are replaced in the ends and the sugar shaken into the enlarged portion of the tube. 10 to 15 c.c. of melted gelatine is then introduced to dissolve the sugar and the mixture is then spread by a twirling motion over the inside of the tube where it is allowed to cool. The instrument is then incubated and the colonies that develop counted. Horizontal rulings about the enlarged portion of the tube divide it into sections and facilitate counting the colonies.

PETRI DISH METHOD

The Esmarch Tube and the Sedgwick-Tucker Aerobioscope and other similar devices give a quantitative bacterial determination. They are, however, somewhat

difficult to handle and satisfactory results are only obtained when used by a trained bacteriologist.

The Petri method, although not as accurate, is much more simple and the results obtained are fairly comparable with the methods previously mentioned.

In Petri's method, a shallow dish (the Petri dish) is coated with the nutrient media, lactose litmus agar being originally used for this purpose. The plate is exposed by removing the cover for a certain time interval. The plate is then incubated and counted over a Jeffers' Counting Plate.

It is best, where possible, to have plates loaded in some health department laboratory, or other place

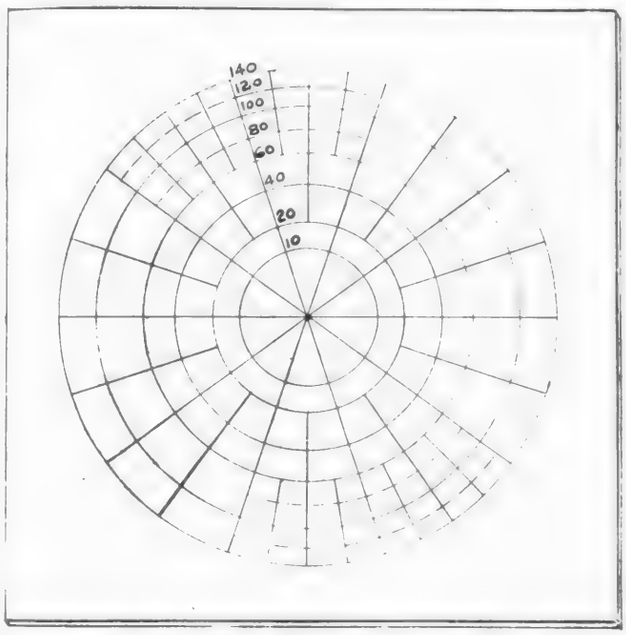


Fig. 26—The Jeffers Counting Plate.

equipped for bacteriological work. If, however, these facilities are not available, hermetically-sealed tubes of media can be obtained from any good bacteriological supply house. Petri dishes can be obtained from any laboratory glassware supply house in 3-in. and 4-in. sizes.

Petri dishes can be loaded by the user if the requisite amount of care is exercised in sterilizing and handling the same. The dishes should be sterilized in a sterilizer designed for this purpose, but when such a utensil is not available, it can be placed in a covered metal pan and placed in a hot oven (the ordinary kitchen range will do for this purpose) and subjected to a heat of 350° to 400° F. for an hour or two. Plates also may be sterilized by immersing them in a solution of 75% alcohol for one hour. If the latter method is used, the cover should be placed over the dish before it is removed from the alcohol bath, the covered dish then held on its side to allow the alcohol to escape. After the alcohol has escaped, it should stand with the cover on for twelve hours.

LOADING THE PLATES

In loading the plates, the tubes of media are placed in a bath of boiling water until the media become liquid. The end of the tube is then broken, the broken end passed through the flame of a Bunsen burner or alcohol lamp, to sterilize the exposed surfaces. The contents are now poured into the plate by lifting one edge of the cover without removing the same. Plates are then placed on ice, or in a cool place until the media harden. They are then wrapped in paper or placed in cloth bags for transportation to the place where the tests are to be made. The cover must never be lifted from the dish until the plate is ready to be exposed.

EXPOSURE

In exposing plates for air cultures, they should be placed in the correct position and the cover removed, but allowed to remain suspended on the edge of the lower dish (see Fig. 25). In this way the lower edge of the cover is not brought into contact with the surface of the desk or other place on which the dish is placed and the liability of contaminating the plate is lessened when the cover is replaced. At the end of the exposure, usually two minutes, the cover is replaced and the dish is wrapped in paper or placed in its bag, inverted and maintained in this position until the count is made. The plate is inverted to prevent condensation of moisture from the cover running into the plate and contaminating the culture.

INCUBATION

Plates are usually incubated from 24 to 48 hours at a temperature of 98° F. At the end of this time the separate colonies have developed to a size where they are easily counted. If an incubator is not available, colonies may be grown at room temperature of 70° for five days.

COUNTING THE CULTURES

For counting cultures the Jeffers Counting Plate is convenient and is usually employed. An illustration of this (Fig. 26) will enable anyone to make a drawing of the plate on white paper or cardboard which answers the purpose very well.

In using the counting plate, place the Petri dish with the cover removed directly over the center of the counting plate. The number of colonies in each section are now counted, beginning usually with the inner circle and proceeding systematically to the outside of the plate.

Counts in sanitary, well-maintained school rooms usually run from 3 or 4 to 10 or 12. They should not be higher than this. The standard time exposure, looked at entirely from the standpoint of convenience, is two minutes. Stitt compared the number of colonies obtained on Petri dishes with the number obtained with the Sedgwick-Tucker Aerobioscope and states that a ten-minute exposure of the Petri dish gives approximately the same number of colonies as the Aerobioscope. On this basis it is necessary to multiply the number of colonies on a two-minute plate by five (5) to obtain a quantitative determination comparable with Aerobioscopic results.

(To be continued)

Moisture Indoors and Out

Information Which May Be Passed on to Advantage to the Prospective User of Humidifying Equipment

By G. J. O'Connor

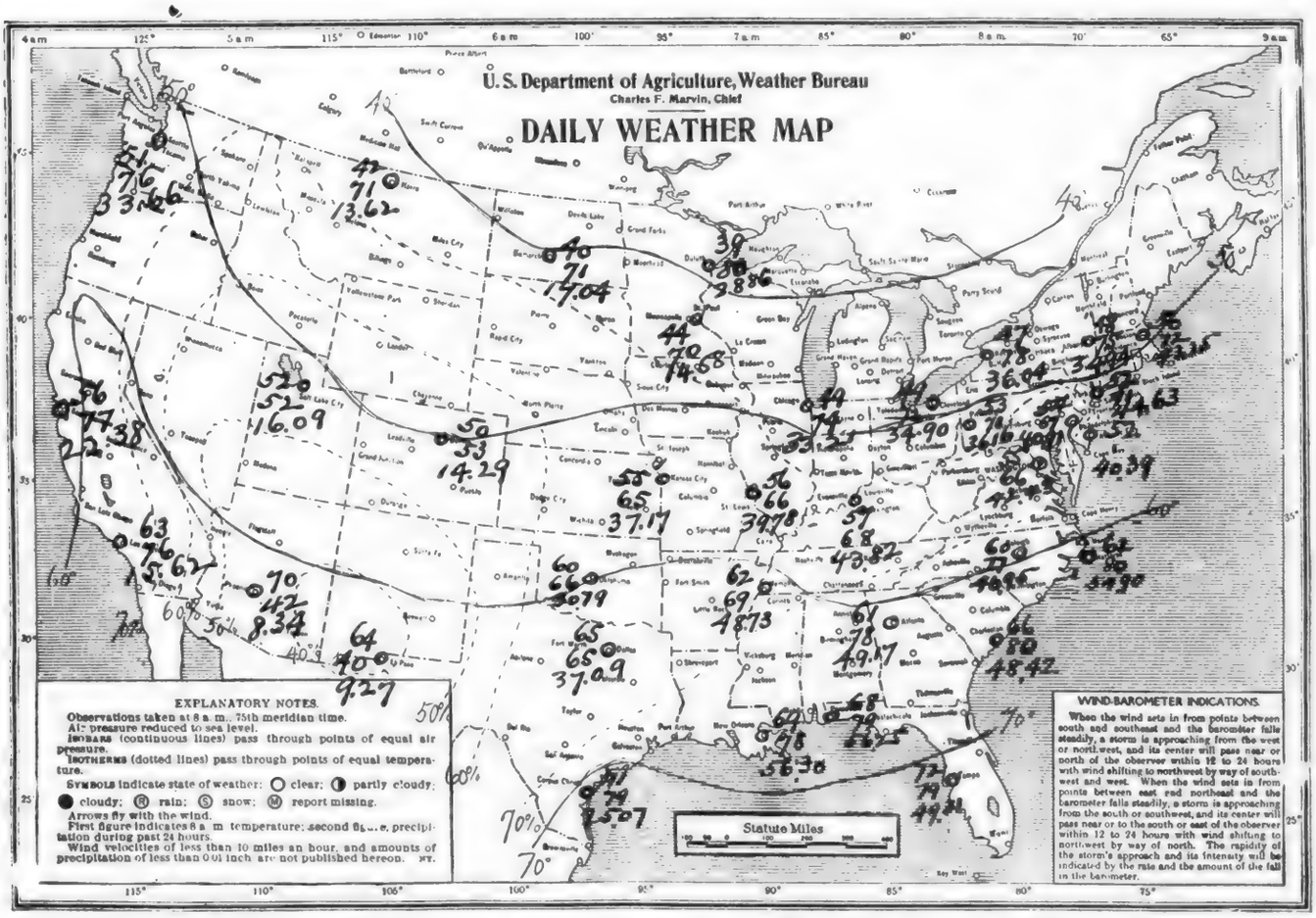
THE question of humidity and its effects on comfort indoors and out, in summer and in winter, is very complex. Moisture is the element of the atmosphere upon whose variability the weather itself depends. An excess of it causes perspiration in days of heat, and fog or rain in the open, whatever the season. In its absence in the home, as we know, we experience the cracking of woodwork and furniture, and the overworking of the mucous membranes of the respiratory tract of the nose and throat; more heat becomes necessary to secure the same amount of comfort.

One term does not suffice to tell all that is known about atmospheric moisture. It is not measurable in degrees, like temperature. In its invisible gaseous state it is a vapor, whose pressure is expressed in thousandths of an inch of barometric pressure. In its absolute state it has a quality which is determined by the number of grains per cubic meter.

As a day with normal atmospheric conditions advances, it is observed that the moisture in the air acts adversely with the temperature, being very high in the early morning and low about mid-day or shortly after. The ventilating or evaporating processes take place more readily under a noonday, cloudless sky. But when a change in the weather is indicated the amplitude of moisture, like that of temperature, narrows down; much of the water contained in the air becomes condensed in the formation of clouds.

Sometimes clouds thus formed travel hundreds of miles en masse; then again, under varying atmospheric conditions peculiar to altitude and latitude, they may evaporate and disappear in whole or in part, as the storm which they attend diminishes in intensity. From the time of the first appearance of tiny crystals, or minute water droplets, in cloud formation, high up in the sky, until the earth is enshrouded in dense fog, or drenched by a downpour of rain, there is a gradual increase in moisture near the surface. Sometimes the increase is rapid, as preceding a thunderstorm on a summer afternoon. One hundred per cent. of relative humidity, of course, means total saturation.

Thus we come to realize a changeable amount of mois-


U. S. Department of Agriculture, Weather Bureau
Charles F. Marvin, Chief
DAILY WEATHER MAP
EXPLANATORY NOTES.
Observations taken at 8 a. m., 75th meridian time.
Air pressure reduced to sea level.
ISOBARS (continuous lines) pass through points of equal air pressure.
ISOTHERMS (dotted lines) pass through points of equal temperature.
SYMBOLS indicate state of weather: ○ clear; ◑ partly cloudy; ● cloudy; (R) rain; (S) snow; (M) report missing.
Arrows fly with the wind.
First figure indicates 8 a. m. temperature; second figure, precipitation during past 24 hours.
Wind velocities of less than 10 miles an hour, and amounts of precipitation of less than 0.01 inch are not published hereon.
WIND-BAROMETER INDICATIONS.
When the wind sets in from points between south and southeast and the barometer falls steadily, a storm is approaching from the west or northwest, and its center will pass near or north of the observer within 12 to 24 hours with wind shifting to northwest by way of southwest and west. When the wind sets in from points between east and northeast and the barometer falls steadily, a storm is approaching from the south or southwest, and its center will pass near or to the south or east of the observer within 12 to 24 hours with wind shifting to northwest by way of north. The rapidity of the storm's approach and its intensity will be indicated by the rate and the amount of the fall in the barometer.
Statute Miles

Annual Distribution of Precipitation, Moisture and Temperature Throughout the United States.

Upper figures at stations represent annual mean temperature in deg. F. Middle figures represent annual mean percentage of relative humidity from observations at 8 A. M. and 8 P. M., 75th meridian time. Lower figures represent annual average precipitation in inches. Heavy isothermal lines pass through places of equal temperature. Dotted lines pass through places having approximately the same relative humidity.

ture in the air. In quantity it is relative accordingly as it affects our sensibilities to a greater or less extent. When the humidity is low, we can withstand the high temperature of a warm day, but a high humidity develops a sultriness of atmosphere that is quite unbearable, even in winter. Physicians assure us that there is twice as much water in the composition of the human body by actual weight as there is of all other components combined. In a low humidity this moisture in the body is taken up rapidly by the surrounding air; it evaporates from the pores of the skin; but in high humidity it condenses, forming perspiration at the surface. Thus we become sensitive of a measurable water content in the air. When measured within a given space this content is termed absolute humidity.

ABSOLUTE HUMIDITY AN INDEX TO CHARACTER OF CLIMATE

From a study of the humidities and rainfall from the records of the U. S. Weather Bureau, it is found that the relative humidity of a locality is not as reliable an index to the character of the climate as is the absolute quantity. The attention of the medical profession has been called to this because physicians had been accustomed to using tables of relative humidity as guides to the comparative dryness of different localities. These tables are dependable in a way. But the ratio between the relative and the absolute humidity is by no means constant. It varies in different localities under different climatic conditions. For instance, the average annual relative humidity at New Orleans, La., and at Ashville, N. C., is 78%; but the density of water vapor at the former city is 14 grams to every cubic meter of space, while at the latter it is only 7 grams.

Thus, in the open, consideration is had of a high and dry climate, as compared with the low and moist. Proximity to large bodies of water, the temperature of which varies but little the year round, has much to do with the presence of moisture in the atmosphere.

A warm day in the arid atmosphere of the Rocky Mountain and southwestern states, with the humidity lower than 20%, which is not uncommon, is maddening in its effects upon the sensibilities of man there. Such dryness is quite inconceivable to the inhabitant of a coast city. Nor is this dryness peculiar to elevation alone, for to the southward of Colorado the elevation slopes to near sea level in the Rio Grande valley, and to below sea level in parts of Arizona. The sombrero protects the head from the burning heat of a summer day when the temperature attains a maximum of more than 100° F. At night blankets are necessary in that country for bodily comfort, due to the fact that the atmosphere has less than 25% of relative humidity.

The accompanying chart illustrates the annual distribution of precipitation and moisture, as well as temperature, throughout the United States. It is based upon observations made at the designated stations for from 25 to more than 50 years. The states of the north and northwest lie in the beaten track of storms crossing the continent. These storms attract to that region warm, moist air from the Gulf States, causing a high relative humidity there. But the processes of condensation over the Plateau region are not adequate to produce precipitation like those influences do over the Great Lakes and eastward thereof.

HOW THE SAME PRINCIPLES OF ATMOSPHERIC MOISTURE APPLY TO HOMES

These same principles of atmospheric moisture are illustrated in homes and apartments that are not humidified artificially. The air in homes, having a low relative humidity, greedily laps up moisture from furniture, rugs, woodwork and from bodies within. If we open the doors and windows, when the temperature outside is near zero, thereby effecting a complete change of atmosphere, upon closing up and heating up to the living-room temperature of 70° F., it will be found that the humidity within the home is very low.

While the temperature is at 70° F., or below, one seldom perspires. Air at 70° never heats the body; on the contrary, it takes heat away from the body. When to this loss of heat from the body is added the loss of heat caused by evaporation (which is constantly taking place when the humidity is low) it can be understood why one feels chilly sometimes when the thermometer in a room would seem to indicate that the body should be warm.

When It Pays to Burn Oil Instead of Coal

By W. F. Schaphorst

TO use the chart it is only necessary to zigzag across, as indicated by the dotted lines, and column G, which is pointed at by the arrow at the top, tells the number of B. T. U. there are to each ton of coal or gallon of oil. That is, the same column, column G, applies to both oil and coal.

In figuring the oil begin at the left and zigzag toward the right. In figuring coal begin at the right and zigzag toward the left to column G. If the oil, for instance contains 20,000 B. T. U. and the specific gravity is 0.9, and if the boiler efficiency with oil fuel is 80%, the zigzag dotted line drawn across the chart from column A to column G through these respective figures shows that each cent will buy 24,000 B. T. U.

Begin at the 5¢, column A, and run through the 80%, column B, with a straight line. This locates the intersection with column C. From this intersection pass through column D, at 20,000 B. T. U. to column E. From this last intersection go through the 0.9 column F, and the final intersection with column G then gives us the answer—24,000 B. T. U. for each cent.

Now comparing with coal, we begin at the right. If coal costs $8.00 per ton of 2,000 lbs., and if the boiler efficiency using the same boiler as above is 70% with coal and if each pound of coal contains 11,000 B. T. U., each cent will buy about 19,200 B. T. U., as shown in column G.

As will be noted, the $8.00 is found in column L, 70% boiler efficiency is in column K. Run a straight line through both points and locate the intersection in column J; run a straight line through the 11,000 in column H and the intersection with column G gives us 19,200 B. T. U.

In other words, the solution of this problem indicates that the use of this oil at 5¢ per gallon will furnish nearly 5,000 B. T. U. more for each cent than will coal at $8.00 per ton.

In using column A the cost per gallon should include all costs—cost of hauling, cost of storing, etc.

It is well known that boiler efficiencies with oil are usually greater than with coal. The difference often is as much as 10% as in this problem where we use 80% in column B and 70% in column K.

Regarding specific gravity in column F, an easy way in which to determine this is to take any vessel such as a pail, jug, or bottle and weigh it. Then fill it with water and weigh again. Subtracting the weight of the vessel gives us the weight of the water. Now do the same with oil and the exact weight of an equal volume of oil is obtained. Now divide the weight of the oil by the weight of the water. The quotient is the specific gravity. The less delicate the scales used for weighing, the greater should be the size of the vessel.

Where a sample of the oil is not available and where the density of the oil is given in degrees Baumé, the following table will be found useful in connection with column F:

Degrees Baumé	Specific Gravity
10	1.0
15	0.97
20	0.93
25	.90
30	.88
35	.85
40	.82
45	.80
50	.78
55	.76
60	.74
65	.72
70	.70
75	.68
80	.67
85	.65
90	.64
95	.62
100	.61

To calculate the specific gravity, knowing the degrees Baumé, simply add the degrees Baumé to 130 and divide the sum into 140. The quotient is the specific gravity.

As for the cost of coal, column L, this is similar to column A and must include all costs, such as hauling, storing, pulverizing, and, if purchased some time ago, the interest on the purchase price.

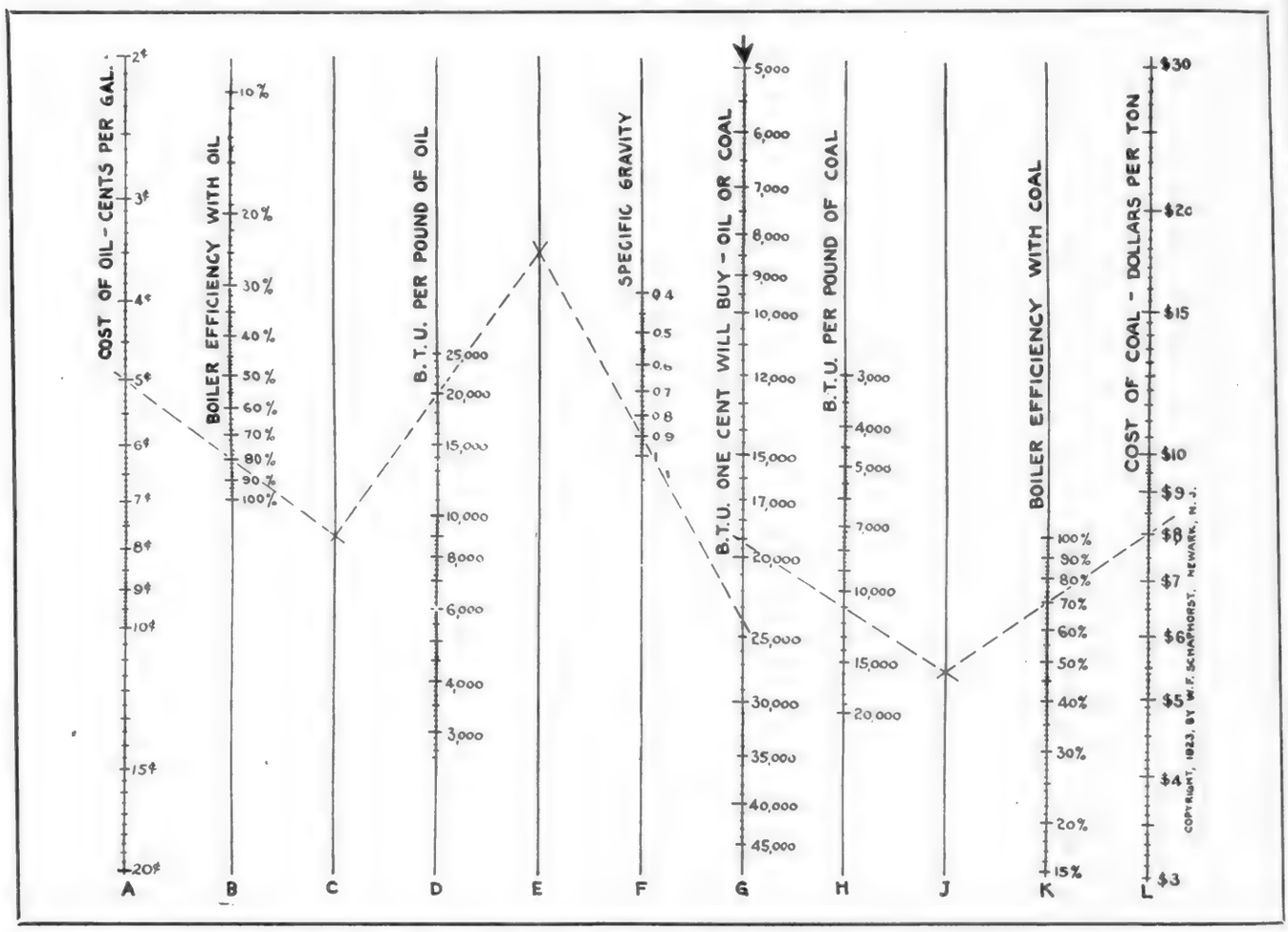


Chart for Determining Cost of Oil and Coal Under Various Conditions.

This chart may be used in several ways for solving various problems. Thus by zigzagging clear across from left to right from column A to column L, knowing the cost of oil and all the necessary intermediate factors, column L gives the equivalent cost of coal. Or zigzagging toward the left from column L we get the equivalent cost of oil. Thus with coal at $6.00 per ton and the boiler efficiency at 70% we would find that a heat value of 10,300 B. T. U. per pound of coal would give us no advantage in using oil as regards cost of oil.

Efficiency of the Oil Flame

By H. A. Geauque and George T. Parker

THE advantage of the use of oil over coal-fire furnaces has been expressed in various ways by different authors, some laying stress upon the proper utilization of the heat.† Other authors give a more elaborate classification of the advantages of oil as a fuel including; (1) labor cost less; (2) takes care of heat load; (3) coal dust and ashes are eliminated; (4) it is more cheaply delivered and distributed.‡

This list could be greatly enlarged and there is no reason why one should stop with four points when such things as distribution of heat and its intensity, ease in application, and quick control are as important as any mentioned; many others could be added which are no less important.

With the many advantages and the increasing use of oil as a fuel, the importance of some method of control of the flame to secure the maximum efficiency in the combustion of the oil, and a definite method to be used and standards to be obtained, are of increasing importance.

STUDY MADE OF RELATIONSHIP OF TEMPERATURE TO CO_2

Many claims have been made regarding the high percentage of carbon dioxide in flue gases of oil burners, so a study of the relationship of temperature to the percentage of carbon dioxide in the flue gas was undertaken to determine the relationship of the combustion to the quantity of air forced through the flame, and the temperature of the flame.

The type of fuel used varies considerably but, with the lighter fuel-oils, the average hydrocarbon is probably represented by the formula C_{16} H_{34}. The quantity of this oil, or the percentage, cracked during vaporization probably varies considerably, but the ease with which it is distilled would indicate that it is more or less stable at moderate temperatures. Vaporization also takes place at a point where a large quantity of air is being admitted to the fire-pot and this would tend to keep the vaporization temperature much lower than the temperature at the peak of the flame.

On the assumption that only a very small part of the hydrocarbon is cracked, the maximum percentage of carbon dioxide in the cooled flue gas can be calculated as follows:

$$2C_{16}\ H_{34} \text{ plus } 49O_2 = 32CO_2 \text{ plus } 34H_2O.$$

If we apply Avogadro's hypothesis and assume that the water vapor is all condensed before the gas reaches the absorption bulbs for the carbon dioxide analysis and if we also assume a factor of ratio of oxygen to air as 1/5, we can write the reaction in the following manner: 2 volumes distillate plus 245 volumes air give 32 volumes carbon dioxide plus 196 volumes nitrogen and inert gases.

This gives us a ratio of 32 volumes of carbon dioxide in a total of 228 volumes of flue gas, which will give a percentage of 14.03% carbon dioxide.

Other hydrocarbons will give theoretically percentages of carbon dioxide in flue gas in somewhat different values, but the hydrocarbons in light fuel-oils will not vary much from this calculation.

In making a study of the conditions for a maximum burner temperature, it must be considered that an excess of air may be used to create an excessively high temperature in a portion of the fire-pot. This, however, lowers considerably the heat efficiency of the burner and it is a common practice in coal-fire furnaces to admit additional air to complete the combustion.

VAPORIZATION AND SPRAY TYPES OF BURNERS TESTED.

Two types of burners were studied, the vaporization type and the spray type. In the spray type, found in the present market, in which the oil is sprayed by air pressure, the quantity of air seems to be governed by the necessity to spray the oil, rather than the amount necessary for combustion. A study of the effect upon the efficiency resulted in the stopping of the spray, the burner, of course, being extinguished.

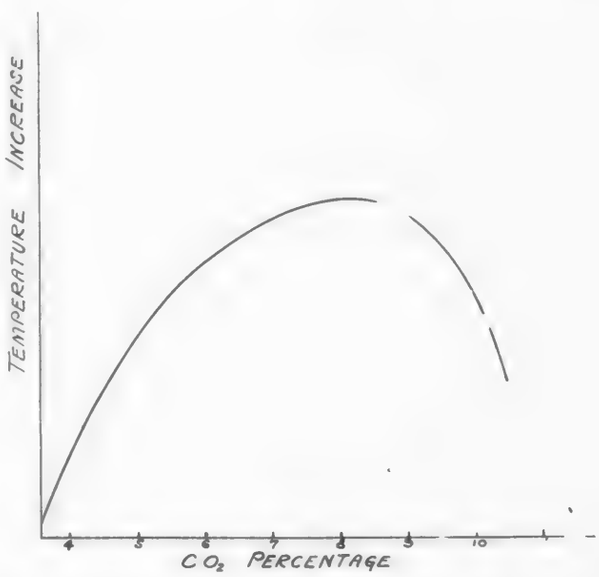


Fig. 1—Relations Between Temperature and Percentage of Carbon Dioxide in the Flue Gas.

The maximum carbon dioxide in this type of burner was found to vary between 4% and 5%, 4.6% being the average. These conditions can probably be made more favorable by several adjustments, but it was found impossible by the author to keep the oil supply constant and change the amount of air supplied to the burner. In this type of burner, the oil supply, of course, depends upon the velocity of the air current.

In studying the vaporization type of burner, the air could be controlled and the relationship of the temperature to the quantity of air necessary for the maximum efficiency was easily found. Fig. 1 shows the relationship between the temperature and the percentage of car-

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* Professor Geauque is head of the Chemical Department of Lombard College, Galesburg, Ill.

† E. Chabanin, Chimie and Industrie, Vol. 3, Page 566, 1920.

‡ W. N. Best, Mining and Met. Vol. 163, Page 35, 1920.

bon dioxide in the flue gas. The oil supply was held constant during these readings and the air supply was diminished. The maximum air supply that the burner could possibly handle was used as a starting point and the readings were taken as the air supply was diminished.

As is indicated on the curve, both the percentages of carbon dioxide and temperature were found to increase to approximately 8.3% carbon dioxide. After that, a quick break in the curve, giving a lower temperature, shows that above this point, at least, the efficiency is quickly lowered. There is only a comparatively small change in temperature and this would indicate that an average in this case would be perhaps the most efficient under this condition.

The conclusion from a study of the flue gases of the ordinary marketed types of oil burners can be summed up as follows:

1. A control of the air supply is very advantageous.
2. The air supply should be such that the carbon dioxide in the flue gas should come within 6.6% and 8.3%.
3. The construction of the burner should be such that a change in regulation should not affect the mechanical action of the burner.
4. An excess of forced air should be avoided because of the serious cooling effect it has upon the flue gas.

Substantial Performance of Heating and Ventilating Contracts

Typical Exceptions to the General Rule Requiring Strict Compliance with the Plans and Specifications

By John Simpson

AN EXCEPTION to the general rule requiring strict performance of a contract before recovery can be had thereon is admitted in the case of building contracts, where the contractor has undesignedly departed from the contract provisions in minor particulars; and the contractor is permitted to recover the contract price notwithstanding slight defects, deviations or omissions for which compensation can be allowed to the owner, if he has sustained any damage therefrom.

Where by inadvertence or mistake a minor deviation has been made, which involves no damage to the defendant, and defendant takes possession of and continues to use the building, without seeking to disturb in any respect the work done by the contractor, the contractor is entitled to prove that he had substantially performed, that the defendant suffered no damage through such innocent mistake, and that what the owner received is what he had the right to expect to get under his contract. Jacobs & Youngs v. Kent, 187 N. Y. App. Div. 100, 175 N. Y. Supp. 281.

GOOD FAITH OF CONTRACTOR

Where the contractor in good faith intended to comply with the terms of the contract, and has substantially done so, but there are some slight omissions or defects caused by inadvertence or mistake, which are not so essential as to defeat the object of the parties, or, as it has sometimes been expressed, do not go to the root of the subject matter of the contract, but are easily susceptible of remedy, so that an allowance out of the contract price will give the other party full indemnity and give him in effect just what he bargained for, the contractor may recover the contract price, less the damages on account of such defects or omissions. Foeller v. Heintz (1908) 137 Wis. 160; Leeds v. Little, 42 Minn. 414, 419; to the same effect Woodward v. Fuller, 80 N. Y. 312, 315; Manitowoc Steam Boiler Works v. Manitowoc Glue Co. (1903) 120 Wis.

But to justify a recovery upon the contract as substantially performed, the omissions or deviations must be the result of mistake or inadvertence, and not intentional, much less fraudulent; and they must be slight or susceptible of remedy, so that an allowance out of the contract price will give the other party substantially what he contracted for. They must not be substantial and running through the whole work, so as to be remedyless, and defeat the object of having the work done in a particular manner. Elliott v. Caldwell (1890) 43 Minn. 357, 360.

A NOTABLE DECISION ON SUBSTANTIAL PERFORMANCE

The Supreme Court of California, in Thomas Haverty Co. v. Jones, 197 Pac. 105, a recent case on a contract for the construction of a plumbing, steam heating and ventilation plant in a building, quoted, as being one of the clearest statements of the law on the subject of substantial performance, from Handy v. Bliss, 204 Mass. 518, 90 N. E. 864, as follows: "There must be such an approximation to complete performance that the owner obtains substantially what was called for by the contract, although it may not be the same in every particular, and although there may be omissions and imperfections on account of which there should be a deduction from the contract price. It is not necessary that the work should be complete in all material respects, nor that there should be no omissions of work that cannot be done by the owner, except at great expense or with great risk to the building. There may be omissions of that which could not afterwards be supplied exactly as called for by the contract without taking down the building to its foundations, and at the same time the omissions may not affect the value of the building for use or otherwise, except so slightly as to be hardly appreciable. Not withstanding such omission, there might be a substantial performance of the contract. . . . An intentional omission to do certain things called for by the contract, if he be-

lieves they are not called for, and intends in good faith to do all that he has agreed to do, does not prevent the application of the doctrine."

WHAT CONSTITUTES SUBSTANTIAL PERFORMANCE

The question what constitutes substantial performance is always one of some difficulty and is usually to be determined in each case with reference to the existing facts and circumstances. It may, therefore, be of assistance to pass in review some decisions in which the courts have been called upon to determine what is and what is not substantial performance of a heating and ventilation contract.

In the Haverty case, just mentioned, the actual cost of the building, including the Haverty contract, was about $186,000. The contract price of the heating, plumbing and ventilation contract sued on, including the extras, was $27,322.66. The sum of $99.20 deducted as the cost of remedying the curable defects, was disregarded as a trivial matter.

The sum of $2,180.88, allowed as damages for so-called irremediable defects, seemed to the court at first to be rather large to come within the rule as to substantial performance. Of these there were twelve, and in ten of them the court found that the material and construction substituted for that specified was equally as efficient and durable as that which was specified would have been. Only those having some connection with the heating and ventilating installation need be noticed here. These were: (1) The failure to install air chambers at the top ends of service pipes for hot and cold water in the attic; (2) The installation of cut-out valves on the hot water pipes in the attic, instead of installing them near to the ceiling of the top floor; (3) The substitution of ¾-in. pipe for 1-in. pipe in eleven out of thirty-one of the hot water pipes extending through the third and fourth floors; (4) The substitution of No. 8 steel for No. 10 steel in the breeching of the boiler.

There was also failure to cover with asbestos paper the hot-water pipes extending through parts of the second and third stories, which failure was in part due to the fact that the owner inclosed the walls before the covering could be put on. As to this the court found that it was not true that it would or did result in serious damage or injury to the building.

With respect to the failure to install 597 sq. ft. of radiation out of 3,502 sq. ft. required by the specifications, the court found that the radiation as constructed was amply sufficient for the purpose intended.

With respect to the substitution of smaller for larger sizes of cold-water and hot-water pipes the court further found that the smaller sizes were sufficiently ample to supply with water the fixtures connected therewith.

It further appeared from the evidence that the difference between the actual cost of the articles substituted and that of those specified was only $196.32, of which $137.31 was due to the cost of the radiation omitted.

The court was of opinion that the case came within the established doctrine under which a contractor may recover in a suit for the contract price upon showing substantial, though not in all respects complete performance; and judgment for the plaintiff was affirmed.

In Phoenix Iron Co. v. The Richmond (1887) 2 Mackey, 180, the Supreme Court of the District of Columbia held that a contract well and sufficiently to heat an apartment building is performed when the apparatus, with its machinery and equipments, is sufficient in size, quality and power to heat the building, as the same was exhibited in the plans shown to the contractor. The heating contractor could not be held responsible for defects in the design, and in the work of others on the building, such as apertures left beneath the window sills for the settling of the structure; an insufficient furnace chimney; too large an air chamber left open over the boiler; and the diversion of heat required for the working of the apparatus.

LICENSE TO USE PATENTED DEVICES IMPLIED IN SALE.

In Hankee v. Arundel Realty Co. (1906) 98 Minn. 219, an action to foreclose a mechanic's lien for the unpaid balance of the contract price of a steam-heating plant, it appeared that the plaintiff, agreed to install in the defendant's building a heating plant known as the "Paul Vacuum System." The plaintiffs insisted that there had been substantial compliance with the contract on their part. The amount of the contract price was $3,563. The damages proved by the defendant were only $33. The defendant relied on the plaintiff's alleged non-compliance with the provisions of the contract, which bound them to furnish to the defendant a license to use the Paul vacuum system to circulate steam at or below atmospheric pressure. The trial court found that the contract was substantially performed, and held the plaintiffs entitled to a lien, no judgment to enter, however, until they had furnished the defendant with the agreed-upon certificate from the Automatic Heating Company of license to the defendant to use the system. The court at the same time regarded this written certificate as a form, of no practical value to the defendant, license to use the system free from interference by the owner or any other person being an implied one. Under the contract, however, the defendant was entitled to its production.

This was affirmed, the appellate court holding that the case "falls within the familiar rule entitling a building contractor to a mechanic's lien upon the substantial performance of his contract, and despite some slight omission or defects which were not so essential as to defeat his claim, or, as it is sometimes said, do not go to the root of the subject-matter of the contract, but are easily susceptible of remedy."

CASES WHERE NON-COMPLIANCE WAS FOUND

A case in a Municipal Court of the City of New York, McElraer v. St. Joseph's Home, (1913) 143 N. Y. Supp. 235, holds that a contract to install an insurable boiler of a specified capacity was not substantially performed by the installation of an uninsurable boiler of approximately one-third of the guaranteed heating capacity.

In Lymms-Powers Co. v. Kennedy (1914) 33 S. Dak. 355, where the trial court found that there had been a substantial performance of a heating installation contract, and also found that it would require an addition of 300 sq. ft. of radiation to make the heating plant comply therewith, the South Dakota Supreme Court said, though the decision was reversed on another point, that these two findings appeared to it inconsistent, and that with the heating plant so deficient, it could hardly see wherein the trial court was justified in finding that there had been a substantial compliance with the terms of the contract.

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ONE of the most astonishing analyses of the future technical requirements of the master plumber is that recently made by Professor Cleverdon, associate professor of sanitary engineering in New York University, and published in the *Merchant Plumber and Fitter*. After commenting upon the fact that the "branch" of heating and ventilating may be looked upon as the latest addition and "possibly the most rapidly developing" of all those which he embraces under the general heading of sanitary engineering, Professor Cleverdon coolly proposes to allocate this branch to the future master plumber, together with the branches of sewage, sewerage and water supply.

To get the full humor of the proposal one needs to follow the developments, as recounted by Professor Cleverdon, which have led up to the necessity for the "sanitary engineer." As he truly says, years ago civil, mechanical, electrical and mining engineers were men who gained their education from experience in the field and office. Today engineers are usually graduates of engineering colleges. But then he continues: "When one considers the vast sums of money spent annually for buildings and that about 15% of this amount is spent for plumbing and approximately 15% for heating and ventilating, he realizes that the master plumber's problems have reached the magnitude of those requiring the knowledge of the sanitary engineer." Professor Cleverdon then describes what he terms the three principal branches of the trade, in which he includes heating and ventilating, and observes: "The master plumber—sanitary engineer—frequently is called upon to furnish plans, specifications, contracts and estimates and, later, to carry out the construction in any or all of the above-mentioned branches." What no doubt he has in mind when he speaks of the master plumber designing heating and ventilating work, are installations for small business buildings and residences. His error lies in thinking that this work compares in volume or importance with the more complicated installations which are the backbone of the industry.

Of course, the facts in the matter are that the tendency is directly opposite to that pictured by Professor Cleverdon. The heating engineer is the one who has been making the big advances in the technique of his profession, and has set such a pace that his work has long since come to be recognized as a distinct branch of engineering. To be sure, the plumbing industry may well look forward to a place of prominence in the engineering field and no one will be more pleased to see such an evolution than the heating and ventilating engineer.

It may be that the men of the future who design the three branches cited by Professor Cleverdon will be known as sanitary engineers, but if so the title will be one that will naturally fall to the present heating and ventilating engineer. The master plumber, who aspires to become a sanitary engineer, as defined in the article quoted, may attain that goal any time he takes steps to become, first, a heating and ventilating engineer.

FEW letters of appreciation have expressed so clearly, even to ourselves, what we are attempting to do in connection with the advertising announcements in THE HEATING AND VENTILATING MAGAZINE, as one we received recently from a western reader.

"It is surprising," he writes, "how one looks at the advertisements in your magazine, as they mean a good deal the same to the engineering profession as the advertisements in the *Saturday Evening Post* mean to the average layman."

It is a trite saying that the advertising columns are as interesting as the reading columns of an engineering journal. The letter quoted, however, tells why this is so. Manufacturers no longer are expected simply to advertise their products. They find it more effective to "present" them to the engineering world through technical mediums by making their appeal in much the same way as they would do if they were personally addressing their audiences. This, we take it, is the quality in the advertisements that has aroused our correspondent's enthusiasm, together, no doubt, with the further fact that our columns are frequently chosen for making premier announcements of new apparatus and methods which, in many cases, have become standard practice in the industry.

It would be ungracious not to give full credit to those advertisers who have taken the initiative in adopting the "informative" policy in their publicity matter, as well as the co-operation of the advertising agencies generally in promoting a clearer and finer expression of their clients' selling arguments. It is due in no small measure to the advertising agencies that our readers are getting so much intelligently-arranged information in the manufacturers' announcements, to say nothing of their skillful use of illustrations and art work to give effect to their points.

Fuels Available for Domestic Use

Notes on Anthracite and Its Substitutes, Based on Recent Investigations of the Bureau of Mines

By Rudolph Kudlich,

Assistant to Chief Mechanical Engineer, Bureau of Mines.

PENNSYLVANIA anthracite coal is almost universally recognized to be the solid fuel best suited for domestic use when cleanliness, convenience and cost are considered. In practically every district in the United States, however, where anthracite has been the common domestic fuel, some other fuel is available as a substitute. In even the most severe climates such fuels are used either as emergency substitutes for anthracite, or as the ordinary domestic fuel. There may be some drawback, such as the need of more frequent attention to the furnace, smoke, soot and dust, in the case of solid fuels lower in price than anthracite, but these inconveniences must be accepted as necessary accompaniments to a decreased fuel bill.

STEAM SIZES OF ANTHRACITE

In speaking of anthracite as a domestic fuel usually only the "domestic" sizes (egg, stove, nut and, to a certain extent, pea) are considered. In the preparation of these sizes a certain amount of smaller sizes (roughly thirty per cent of the total) are produced, which are considered as a by-product and sold in competition with bituminous coal as steam coal, at a price below the actual cost of production.

Although these steam sizes cannot often be burned alone with natural draft at a sufficiently high rate of combustion to produce the necessary amount of heat in the ordinary furnace, they are in use to a considerable extent, either mixed with some other coal or with coke, or unmixed using forced draft. The size usually used is No. 1 Buckwheat or yard screenings, although No. 2 and even mixtures No. 2 and No. 3 Buckwheat are used in certain localities with forced draft installations.

No. 1 Buckwheat and yard screenings can be mixed with the larger domestic sizes (preferably egg coal), with coke or with bituminous coal. The proportions of the two sizes or kinds of coal are contingent on the size of the furnace with relation to the amount of heat to be supplied, on the draft available, or on the outside temperature, and can only be determined by experiment. They may range from equal quantities of each to one part of substitute to three parts of basic fuel. By trial it will be found that the proportion of substitute can be increased in mild weather when not a great deal of heat is necessary, but must be decreased or even omitted entirely during the most severe weather when the furnace must be operated to its maximum capacity.

When using small sizes with large anthracite or coke it is best not to mix them but to fire separately in layers, first a layer of the larger fuel and then a layer of the smaller. When used with bituminous coal which is not sized they should be mixed before firing.

SCHEME FOR REDUCING SIZE OF GRATE OPENING

Occasionally a furnace has sufficient grate area to burn a sufficient quantity of No. 1 Buckwheat to produce the necessary heat with natural draft. In that case, it is only necessary to reduce the size of the grate openings to prevent too great an amount of unburned coal falling into the ash pit. This can most readily and cheaply be done by laying a plate of iron, closely perforated with half-inch holes, or a piece of heavy half-inch square mesh galvanized-iron netting, loosely on the grates. Such "false grates" will in time burn out but can be replaced at low cost.

Ordinarily it will be found that forced draft is necessary. This can be created by a small electrically-driven fan or blower connected with the ash pit and either automatically or manually controlled. The ash pit should be made as tight against air leakage as possible. The stove pipe damper must not fit tightly, to avoid the possibility of the furnace gases being forced into the cellar instead of escaping through the chimney should the damper be accidentally closed.

VIRGINIA ANTHRACITE

A small district in Virginia produces a semi-anthracite, ordinarily called "Virginia anthracite." Heretofore this coal has been produced in only very limited quantities and supplied only to the local trade. Recently this district has been developed and a greatly increased tonnage will be available for the southern portion of the anthracite-using region. This coal is smokeless and compares favorably with Pennsylvania anthracite as to heat value and ash content when properly prepared. It will be marketed as prepared sizes similar to Pennsylvania anthracite and also in the form of briquets.

ARKANSAS ANTHRACITE

Certain districts in Arkansas produce a coal intermediate between Pennsylvania anthracite and low volatile bituminous coal. It is an excellent domestic fuel, practically smokeless, and about equal to Pennsylvania anthracite in heat value. Recent increases in the price of Pennsylvania anthracite and readjustments in freight rates now enable this coal to compete with the latter in the territory served by the Great Lakes docks and it is now appearing in increasing quantities in this market.

BITUMINOUS COAL

The bituminous coal resources and production capacity are so large, as compared with anthracite, that as the supply of the latter becomes exhausted we must look more and more to bituminous coal—either as produced or processed—to supply our domestic demands.

Bituminous coal (using the classification of the ordinary consumer) occurs in a practically endless variety ranging from the high grade low volatile semi-bituminous coals, or "smokeless" coals of the east, through the various medium and high volatile true bituminous coals to the high moisture, high volatile sub-bituminous coals of the West. All these coals can be and are used as domestic fuel but their desirability for that purpose varies with the ease with which they can be handled and their cleanliness and the degree to which they cause smoke and soot.

Local habits and conditions largely influence the class of coal which is used as domestic fuel. Where smokelessness is an important consideration, and the coal is largely used in furnaces, the smokeless semi-bituminous coals of Virginia and West Virginia are desired. In the South where coal is used largely in open grates and fires are not kept up continuously, a long flame, free-burning coal which can be readily ignited and handled without much dirt best fills the demand.

SEMI-BITUMINOUS COAL

The semi-bituminous coals, embracing the "smokeless" Pocahontas, New River and Georges Creek coals of Virginia, West Virginia and Maryland and the smokeless Clearfield coal of Pennsylvania are probably the best adapted of any "soft coal" for use as a substitute for anthracite. If properly fired and the drafts properly regulated, these coals can be burned without smoke and will deposit very little soot in the furnace and smoke pipe or chimney.

These smokeless coals are available in practically all the eastern markets where anthracite is the customary fuel. They are higher in heat value and usually contain less ash than anthracite, and as a general rule can be bought considerably cheaper.

All coals of this class are extremely friable and cannot be graded in size as is anthracite. A large proportion of the coal as delivered will be in small sizes grading down to dust. Many people not accustomed to this coal are reluctant to accept it, considering the fine sizes as dirt. As a matter of fact, this fine coal contains less ash and will give off more heat than the large pieces. This coal has the property of "coking" that is of fusing together when heated, so that if properly

fired it will form large pieces which do not fall through the grate to the ash pan. Because of its large percentage of fines, this coal is somewhat dusty and dirty to handle dry. If well wet down before it is put in the cellar, and if the front of the pile in the bin be kept moistened with an occassional bucket or two of water, this dirt can be largely avoided.

MEDIUM AND HIGH VOLATILE BITUMINOUS COAL

The greater proportion of bituminous coals belong to the true bituminous coals and are classed either as medium volatile or high volatile, according to the percentage of volatile matter they contain. Volatile matter may roughly be defined as that part of the coal which may be driven off as a gas at a temperature below the ignition point of the coal, and is of interest to the consumer as a measure of the amount of smoke and soot which may be given off in burning it.

These coals are produced in practically all the fields west of the Allegheny Mountain ridge. They are available in all regions where the more desirable smokeless are not available and are considerably cheaper than anthracite or smokeless coal. Their characteristics vary considerably as to smoke production, heating value, and ash content. Those coals produced in the eastern fields are generally high in heat value, comparing in this respect with the best anthracite, while others have as low as 75% of its heat value. The medium volatile coal may be burned with very little smoke while some high volatile coals can be used only in specific heating equipment and under certain conditions of firing to avoid serious smoking.

As regards physical characteristics, these coals are usually much harder than the smokeless coals, are often carefully sized for domestic consumption, and can be handled without much dirt. Some of these coals form a strong coke and require attention between firings while others are as non-coking as anthracite and can be used in base burners and hot blast stoves designed for its use.

Although these coals are not so convenient to use as anthracite or semi-bituminous coal, they are well adapted to domestic use as is evident from the fact that they represent the bulk of the coal used as domestic fuel west of the Allegheny Mountains and south of Virginia, with the exception of the territory served by the Great Lakes docks.

BURNING BITUMINOUS COALS

To use semi-bituminous and bituminous coals in the furnace, a somewhat different method of firing from that used in burning anthracite must be used. When the coal is thrown on the fire the volatile matter is driven off by the heat and, unless mixed with additional air above the fire bed and ignited, will pass off through the chimney, causing excessive smoke and soot. To supply the additional air, the fire door register should be opened or, if this is insufficient, the fire door left partly open until the volatile matter has been driven off and the coal is burning with a visible flame, after which this auxiliary air supply may be reduced or entirely cut off by closing the door and register. Only enough air should be admitted over the fire to prevent smoking, as an excess is wasteful of fuel. The proper amount varies with different kinds of coal and different equipments and can be determined only by trial.

To ignite the gases, the live fuel bed should never be entirely covered with fresh fuel. This can be avoided by pushing the burning coal or coke to one side or to the back of the fire pot and adding the fresh fuel to the other side or front. The entire amount of coal used at one firing can be put in at once if smokeless coal or low volatile coal is used but if high volatile coal is used only a small quantity at a time should be put on, allowing sufficient time between firing for the preceding charge to give off its volatile matter. If a coking coal is used, the coke will form on one side of the fire box while that on the other side is forming. At low rates of combustion this coke need not be disturbed, but if more heat is desired or when adding fresh coal it should be broken up. The fire bed should not be stirred or poked more than necessary as it will cause an excessive amount of clinkers, and may burn the grate bars.

COKE

As regards cleanliness and absolute smokelessness, coke is the best substitute for anthracite. Coke is the solid residue from the distillation of certain grades of bituminous coal in the beehive coke oven, the by-product oven or the gas house retort. Although coke made by any of these processes from the same coal is very similar as to chemical composition, there is some difference in its physical characteristics. Coke is practically free of volatile matter, the smoke producing constituent of bituminous coal. If only the necessary amount of water has been used to quench it and it has not been exposed to wet weather, the moisture content is very low although, if an excess of quenching water has been used or if it has been exposed for a considerable length of time in wet weather, it may contain a serious amount of moisture. The ash and sulphur content are dependent on the grade of coal used for its manufacture and can be kept quite low if suitable coals are selected.

As to physical characteristics, coke is porous and considerably bulkier than coal. As to burning qualities it is often not so easily ignited as coal but after being ignited burns much more readily because a greater amount of air can come in contact with the coke due to its tendency to pile up loosely in the fire box and its porous texture.

Coke is available to a limited extent in most of the populated regions of this country. In the mining regions where coke is made in beehive ovens a certain amount of domestic sizes is made as a by-product for nearby markets and in certain regions in the East and Northwest domestic sizes of coke are a major product of by-product coke plants. In practically every city where retort gas is made a certain amount of gas house coke is available as a domestic fuel. When using gas house coke in the furnace even closer regulation of the air supply is necessary than when using by-product or beehive coke.

Though the supply of coals suitable for coking and the capacity of the mines producing such coal are sufficient to meet the demands for a considerable time to come, the capacity of the coking plants is limited and cannot meet the full demand for domestic fuel. Although ordinarily the cost of coke lies between that of anthracite and bituminous coal, in times of heavy demand it is usually increased to equal that of anthracite.

BURNING COKE IN THE FURNACE

Coke is handled much as is anthracite except that closer regulation of the drafts is necessary and a small layer of ashes should be allowed to remain on the grate to protect it. In kindling the fire or when adding coke, the draft should be opened wide until it has become well ignited. Then it should be shut down until just sufficient to support combustion at the desired rate. Since, because of the open condition of the coke bed on the grate and the porous character of the coke, a smaller amount of draft is needed than with coal and it may be necessary to close up any open joints in the ash pit or to install an additional damper between the furnace and the check damper.

It will be found that because of its greater bulk the fire box will hold a smaller weight of coke, necessitating more frequent firings.

PETROLEUM COKE

Petroleum coke is the ultimate residue from the distillation of petroleum. It is practically free of ash and higher in heat value than any other solid fuel. It is available in small quantities in only a few localities and usually commands a higher price even than anthracite.

It is used in the furnace much in the same manner as ordinary coke except that an artificial ash bed of fire brick broken to the size of walnuts must be placed on the grate to protect it from the heat and to reduce the draft.

BRIQUETS

Briquets made of anthracite or smokeless bituminous coal are likewise available to a certain extent in certain localities. Their desirability as a fuel is entirely dependent on the care used in the selection of materials and in their manufacture. Good briquets have almost as high a heat value as anthracite and are handled in the furnace as is anthracite.

WOOD

Firewood is used to a considerable extent in rural and forest districts remote from the mines but does not figure extensively as a fuel because of its high cost and need of frequent attention. However, when it must be used as a furnace fuel, the best results can be obtained by using it in as large chunks as can conveniently be passed through the furnace door and burning it on a "dead plate," or piece of sheet iron, placed on the grate.

LIQUID FUEL

With the present state of development of oil burning equipment for domestic heaters heavy, low-priced fuel oil cannot be used in most of such systems but only kerosene and a special light distillate. Kerosene is available practically everywhere but the cheaper kerosene distillate only where a sufficient demand for it has been created. Although the supply is sufficient to fill present demands, should the use of such oil burning equipment become general, it would soon be entirely inadequate.

The cost of kerosene is high as compared with anthracite. Calculating on a heat value basis kerosene costs from one and one-half times to twice as much as anthracite. Allowing for the possible economy which may be effected by increased efficiency of combustion in properly adjusted burners and by starting up and shutting off the furnace as needed instead of banking it as is necessary with a coal fire, the cost will still be in excess of anthracite. In addition, the cost of the installation must be considered.

However, such an oil burning furnace can be operated with a minimum of attention, with entirely automatic regulation and without bother of ash handling; advantages for which many are willing to pay the additional cost.

GASEOUS FUEL

With the exception of the favored communities where an ample supply of natural gas is available, gas from city gas plants or from by-product gas plants represents the only available supply of gaseous fuel. Although it makes an ideal fuel as regards cleanliness and ease of operation its cost is so high as to make it available only as a luxury as a general house heating fuel. For use in local heating in one or two rooms, for cooking and for hot water heating it is largely used and for such purposes the cost is not excessive.

Although available in practically every community of more than a few thousand inhabitants in quantity sufficient for demands, there are a few existing plants which could meet the demand were it suddenly increased by a general use of gas fired heating furnaces.

ELECTRICITY

Electricity, like gas, is very convenient but is even more costly and as regards house heating is feasible only for heating one or two rooms.

SUMMARY

Because of the limited supply and cost of such desirable substitutes for anthracite as a domestic fuel as oil, gas and electricity, we must look mainly to bituminous coal of various grades, or to coke which is made from bituminous coal, as our real substitutes for anthracite.

Coke is more desirable than bituminous coal because of its cleanliness but the present productive capacity is not sufficient to meet the demands for domestic fuel.

The "smokeless" semi-bituminous coal is the most satisfactory substitute available in quantity in most anthracite using districts. It can be used in the ordinary coal burning furnace with only minor changes in the method of firing.

Ordinary medium and high volatile coal, which at present is the recognized domestic fuel for by far the great majority of the people in this country, is available practically everywhere. It can be used in the ordinary furnace but special care must be exercised to reduce the smoke and soot.

Canada Studying the Possibilities of Central Station Heating.

A movement started in Canada through the formation of the Dominion Fuel Board to study the underlying causes of recurring coal shortages and of methods by which they may be counteracted, promises to produce some results that will be of value to heating engineers, as well as to users of fuel generally. For instance, one of the matters being taken up is central station heating, the board having adopted a resolution "to proceed immediately with the investigation of central heating plants, with particular reference to the extent to which their more extensive use may contribute to the solution of the fuel problem, and that a qualified engineer be engaged for this purpose."

The detailed nature of this investigation is still under consideration by the special committee appointed for this purpose. This committee has been in consultation with various organizations and companies, and it is expected that a report on the subject will be published during the Fall.

In the meantime the Dominion Fuel Board has published an interim report which shows how urgent it is that Canada should be independent as regards its fuel supply. As the report states, the country has an abundance of coal, but it is concentrated in the western and eastern extremities, leaving the populous industrial section of Ontario and Quebec dependent on other sources of supply.

As in the Eastern section of the United States, the people of central Canada have been so long accustomed to use United States anthracite for domestic fuel that they have become prejudiced in its favor. The board, however, considers it of the utmost importance that the use of coals of Canadian origin should be more widely extended and that other native fuels should be more fully developed so that the sources of Canada's fuel supply may be widened and diversified.

Among the suggestions offered by the board are: a wider range of utilization of the coals of British Columbia, Alberta and the Maritime Provinces, the use of peat, and even of hardwood.

On the subject of coke, the board is convinced, states the report, of the importance of an investigation into the feasibility of establishing by-product recovery coking plants in the larger centers of population. Briefly the plan would be to establish coking plants at large well-situated centers, like Montreal and Toronto, where the coke could be manufactured and shipped to tributary territory and the gas, which is the most important by-product, used at the point of manufacture.

In this connection the report cites the experience of St. Paul and Minneapolis where a plant was established some years ago for the manufacture of this coke. To-day, it states, coke has displaced anthracite there practically in its entirety. More recent investigation by the board in other parts of the United States, where coke is being manufactured, has confirmed the conclusion that this would be a very fruitful field for further investigation. In fact, the board considers that the developments in this connection hold much promise and as in the case of the central heating investigation it has by resolution decided to employ a competent expert to report upon the matter.

How far central heating plants will prove to be of help will be shown after the contemplated investigation. The board states that several central heating plants are in operation now in Canada, besides those in successful operation in the United States and Europe. One of the largest is that operated by the Dominion Government to heat the Parliament and, some other government buildings in Ottawa. The Board lays special emphasis in its report on the ability of such plants to use low-grade fuel and on the economy in the delivery of fuel at one central point, and in the disposal of ashes. Importance is also attached to the possibility of securing trained engineers in such operations.

Accompanying the report are numerous maps and charts which bring out very clearly the present fuel situation in Canada and the possibilities in the use of substitute fuels. Size 6 x 9 in. Pp. 30. Published by the Dominion Fuel Board, Charles Camsell, chairman, Ottawa, Canada.

Current Heating and Ventilating Literature

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the article mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

FANS

The Selection of Fans and Their Application, A. Fleming Browne. Power Eng., vol. 18, no. 204, Mar. 1923, pp. 105-109 and (discussion) 109-111. Ventilating fans; mechanical draft; cupola fans; dust and fume removal; drying plants; propeller fans; centrifugal fans; fan standardization. 20c.

Notes on Kiln Drying of Wood

Fundamental facts about the drying of wood are contained in a new "Kiln Drying Handbook," which has been published as Bulletin 1136 by the U. S. Department of Agriculture. It was compiled by Rolf Thelen, in charge of the Section of Timber Physics, Forest Products Laboratory of the Forest Service.

The subject, which is presented in a very readable manner, covers such topics as moisture in wood, general principles of drying wood, heat in the kiln, humidity in the kiln, air circulation in the kiln, drying and drying stresses, drying schedules, kiln types, piling lumber for kiln drying, details of kiln operation and air seasoning.

In discussing methods used to heat kilns, the author states that at present steam is in almost universal use for this purpose. It may be high-pressure, above 10 lbs. per square inch, or low-pressure, below 10 lbs. The correct temperature of air to use is determined by the character of the wood and varies widely with different kinds of stock. Commercial kiln temperatures range from 100° to 250° F.

PIPE COILS IN MOST COMMON USE FOR KILN HEATING

Discussing the form, construction and arrangement of the kiln radiators, the author states that those constructed of pipe coils are in most common use. These include radiators made of ordinary merchant pipe, extra heavy pipe of various kinds, and wrought-iron pipe, the last being particularly suitable for severe drying schedules. Mr. Thelen cites the advantages of pipe-coil radiators, such as their low first cost, ease of manufacture and installation, ready adaptability to a great range of shapes and sizes, and ease of repair.

Regarding the essentials of a good pipe coil, the author mentions:

1. It must be of such size and shape and so located that it can properly heat the air in the kiln.

2. It must be mechanically strong and durable and provided with means for permitting the expansion and contraction of the individual pipes in the coil.

3. It must provide for the ready escape of the air and water of condensation from the entire system.

4. It must provide for adjustment in the amount of heating surface to be used by cutting certain pipes in or out.

As it is difficult to combine all these essentials in the highest degree in any one type of coil, different ones have been found best adapted for various special conditions.

A large portion of all pipe coils used for dry-kiln heating, continues Mr. Thelen, are located in the kiln proper, between or under the rails. These fall into two general classes, header and return-bend coils. In the former, a number of pipes spring from the same supply pipe or header and return to a similar drip pipe or header, usually but not always, located at the other end of the kiln. In the return-bend type, however, the pipes of each group are connected end to end by means of return bends or double-elbow fittings; steam enters at the front of the first or top pipe, and condensation is removed from the end of the last or bottom pipe.

Several types of kiln use pipe-coil radiators on the side walls. These radiators do not need to differ materially from those located under the lumber, and the great amount of headroom available makes it a simple matter to get rid of the water of condensation from almost any type of coil. It also permits the use of return-bend coils in long kilns without the sacrifice of the pitch required for proper drainage.

Cast-iron radiators of various kinds have recently been introduced for use in dry kilns. They can be had in a wide range of sizes and shapes adapted to practically any space or heating requirement. This type of radiation is higher in first cost than some other types, but great durability is claimed for it on account of the resistance of cast-iron to rust.

BLOWER KILNS

Blower kilns of several types have the heating units located outside of the kiln. These units are usually of the standard types used in blower systems for heating buildings. Practically all of these consist of compactly-arranged groups of pipes or pipe coils made up into cast headers, which form the base of the heater. Sometimes special forms of cast-iron radiators are used. It is good practice, states Mr. Thelen, to equip the heater with valves, so that various portions of it may be used as desired. Such heaters give little trouble, since their design permits unusually easy removal of air and water and the short pipes are free from difficulties caused by uneven expansion and contraction.

In addition to the heating equipment described, some kilns are equipped with ceiling coils. These usually consist of a few runs of pipe spaced a foot or more apart and hung a few inches below the ceiling. They are connected independently and are used most or all of the time. Their function is to replace the heat lost through the ceiling and so prevent the latter from acting as a condenser. During cold weather especially, and when high humidities are used, the ceiling is likely to accumulate a great deal of condensation, which drips down upon the lumber and prevents humidity control.

CONTROL OF KILN TEMPERATURE AND HUMIDITY

The proper measurement of the temperature in the kiln is essential to proper control and, as emphasized by the author, deserves much more time and attention than it usually receives.

Since the humidity in the air determines the drying characteristics at any given temperature, the control of humidity in the kiln is of prime importance. It is essential that the moisture be removed from the wood surface at the maximum safe drying rate. If the humidity is too low the wood will dry too fast and will be injured; if the humidity is too high the drying will be slow and expensive.

It is simpler to increase the humidity in a kiln than to decrease it. The universal method of increasing humidity is to inject steam into the kiln chamber.

Atmospheric air is usually drier than that in the wood-drying kiln and can be used only for dehumidification, a practice common with ventilated kilns. The moist air is drawn off through ventilating flues and the fresh air enteres through intake flues or ducts. As the fresh air is heated

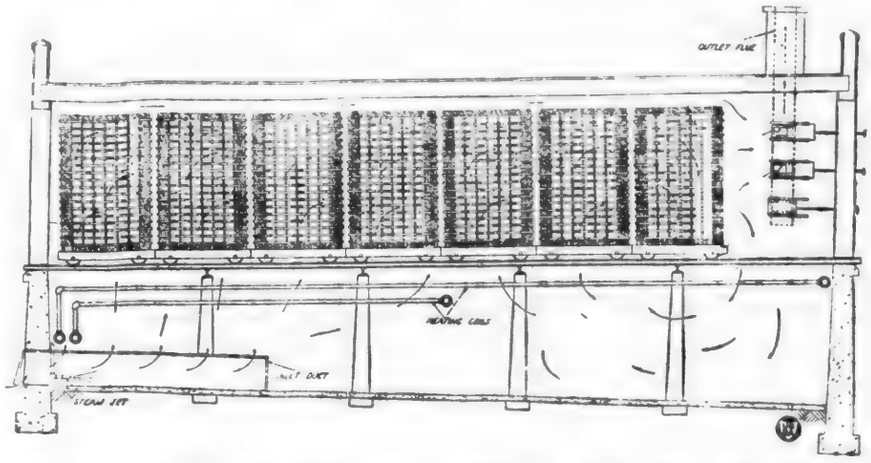


Fig. 1—Section of Progressive Kiln, in Which Lumber Moves from Right to Left, While Air Circulation is from Left to Right.

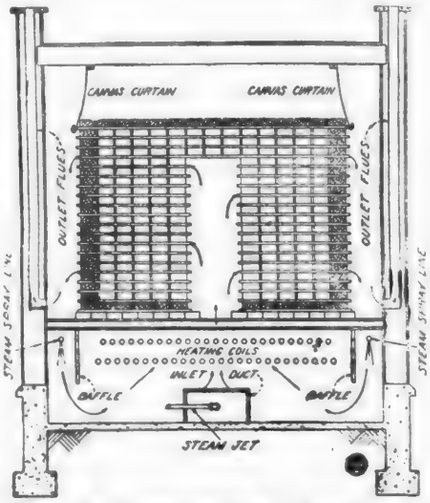


Fig. 2—Cross-Section of Ventilated Compartment Kiln.

its relative humidity falls while the dew-point remains the same.

Moisture may also be removed from the air by condensation. The water vapor in the air condenses as it passes over a substance colder than the dew-point of the air. Condenser pipes with cold water flowing through them are commonly used for this purpose. When cold water is not available, a refrigerator plant may be installed and brine circulated through the condenser pipes.

Cold-water sprays are also used to dehumidify air. The spray temperature must be below the dew-point of the air passing through. If the sprays are powerful enough the air will be cooled to about the temperature of the water and will come out saturated at a temperature below its original dew-point. In other words, the dew-point will have been lowered. If the air be heated to its original temperature it will be drier than it originally was.

The control of humidity is more difficult than temperature control, and greater attention must be given to the

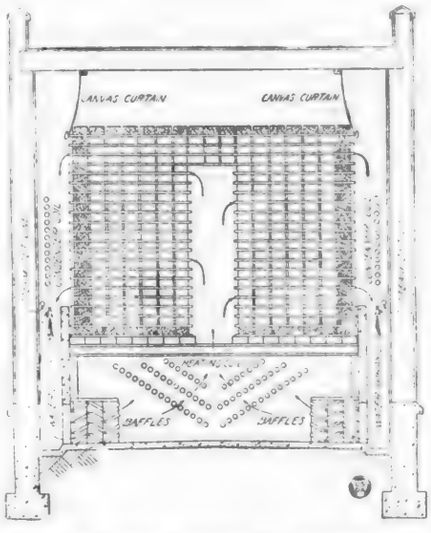


Fig. 3—Cross-Section of Water-Spray Compartment Kiln.

apparatus to secure satisfactory results. One principal reason is that a small difference in the wet-bulb temperature produces a comparatively large difference in humidity, and to secure good control requires an accurate instrument.

AIR CIRCULATION IN THE KILN

It is absolutely necessary to have a certain amount of circulation of air in a kiln to convey the heat from the steam coils or other source to the lumber and to carry away the evaporated moisture.

The simplest way to produce circulation is by means of chimneys or flues. This natural draft is caused by the difference in temperature of the outside air and the air in the kiln. The warm air in the kiln is lighter than the air outside and is continually escaping through the top. The cold outside air is drawn in at the bottom. There is always inleakage at the bottom and outleakage at the top of the kiln, no matter how well it may be built; and when the path of the air is made easy by providing chimneys and fresh-air in-

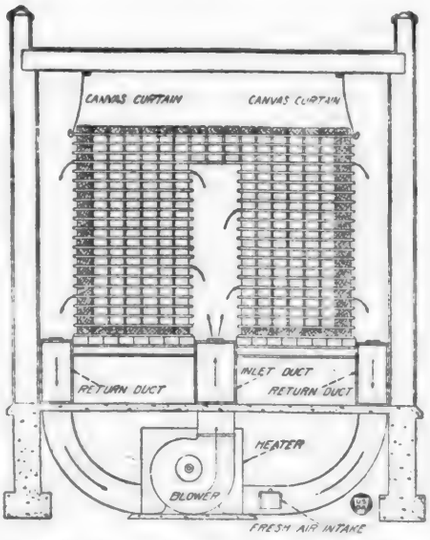


Fig. 4—Cross-Section of Blower Compartment Kiln.

takes the circulation becomes quite brisk. The velocity in the chimneys may be 600 ft. per minute or more, depending upon circumstances. A reasonable amount of draft may be secured through the chimneys, even though no air intake openings are provided.

The Forest Products Laboratory recommends for all difficult drying work which demands uniform drying conditions a circulation of at least 25 ft. per minute through the lumber piles. Where requirements are not so exacting much lower rates may be used. If only the removal of the moisture from the kiln through ventilation is desired, a very low rate may be ample. In fact, certain types of kilns are being successfully operated without any visible means of moisture removal, leakage being sufficient to keep the humidity below the desired point.

SHRINKAGE

As the drying of green wood progresses the amount of free water in the cells gradually diminishes, and soon the cells near the surface have lost all their free water, i. e., they have reached the fiber-saturation point. It is at this point, which is a very definite one for most species,

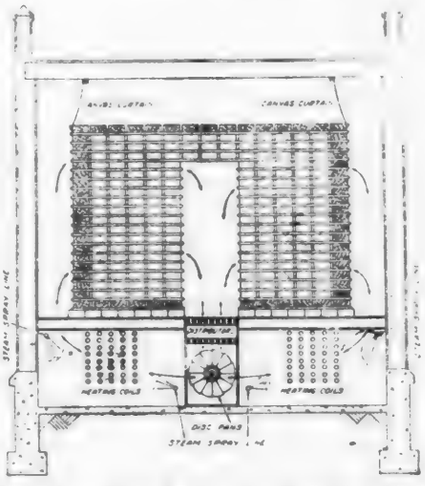


Fig. 5—Cross-Section of Internal-Fan Kiln, in Which a Number of Disk Fans Are Mounted at Intervals Upon a Shaft.

usually between 25% and 30% moisture, that changes in the properties of the wood begin to take place. As wood dries beyond the fibre-saturation point it begins to shrink, and it will continue to shrink as long as it loses moisture. In fact, this shrinkage is very nearly proportional to the amount of drying below the fiber-saturation point. Shrinkage is not uniform in all directions.

Regulation of the drying process and close adherence to drying schedules will help to remedy uneven shrinkage.

TYPES OF KILNS

The bulletin describes the two general classes of dry kilns for wood, commonly known as progressive and compartment. Progressive kilns are sometimes called "continuous" kilns, and compartment kilns are known as "box" or "charge" kilns. The differences between the two types de-

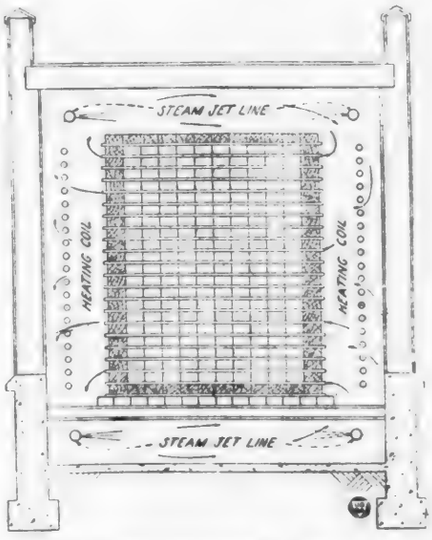


Fig. 6—Cross-Section of Superheated Steam Compartment Kiln.

pend on the method of handling the stock through the kiln.

Almost all progressive kilns are of the natural-draft type, although a number of progressive blower kilns have been built. The air usually enters through ducts at the discharge or dry end of the kiln, is heated by steam coils under the lumber, and humidified by means of a steam jet. It then passes upward through the lumber, horizontally the length of the kiln, and finally out into the atmosphere at the green end through chimneys provided for this purpose.

Ventilated compartment kilns also vary considerably in detailed design. Most of them, however, are arranged for cross circulation, and the fresh air is usually brought in at the bottom and distributed throughout the length of the kiln by means of ducts under the lumber.

The water-spray kiln was invented and developed at the Forest Products Laboratory. As ordinarily designed it embodies the principles of the condenser kiln.

Fans or blowers are used in several types of kilns for forcing the circulation. Blower kilns for drying lumber are, almost without exception, of the recirculating compartment type, and those in

commercial use are mostly of the external blower type.

The superheated-steam kiln is comparatively simple in construction and operation. Provision must be made for high-pressure steam for heating coils and jets; the circulation must be reversed periodically; and the kiln must be designed for short travel of the steam through the lumber.

Success in all except the easiest kind of kiln drying, concludes the bulletin, depends upon the accuracy of the instruments and apparatus used in the regulation of the kiln and in the determination of the moisture content. It is therefore essential that the apparatus be maintained in an accurate operating condition. Most important is the matter of temperature indicating, recording, and regulating instruments, since through them both temperature and humidity are determined and controlled.

Gas in Competition With Coal for Heating Purposes

New rates for gas for heating purposes are announced by two western utilities—the Seattle Lighting Co., Seattle, Wash., and Utah Gas & Coke Co., Salt Lake City, Utah, thus bringing that form of fuel into direct competition with coal for residential heating purposes. Both tariffs provide that customers contracting to use gas for heating purposes may have gas for cooking and other purposes at the reduced rate.

The Seattle Company announced the following rates:

500 cu. ft. or less..	$ .85 gross	$ .75 net
Next 1,500 per M..	1.60 gross	1.50 net
Next 2,000 per M..	1.40 gross	1.30 net
Next 6,000 per M..	.80 gross	.70 net
Over 10,000 per M..	.70 gross	.70 net

According to the Salt Lake City announcement, service will be given at 85 cents net per 1,000 cu. ft. as compared with the present rate of $1.60. The schedule provides, however, for a customer's charge of $1 and an additional demand charge of $2 a month net for each 1,000 cu. ft. of maximum hourly demand.

"The move is more or less in the nature of an experiment" Frederick K. Lane, general manager of the Seattle Company, stated: "We have never before made a special rate on gas to be used for house heating and we have only a very few patrons who are now using gas exclusively for that purpose. The use of gas for auxiliary heating apparatus here is quite common, as everybody knows. Every winter cold snaps cause a big increase in gas consumption. Our belief is that the average 5-room bungalow can be heated in the dead of winter with about 30,000 cu. ft. of gas a month. This, under the new tariff, will cost $23.80. The cost of heating a larger or smaller house will be in proportion.

"We do not anticipate that gas will ever supplant coal for household heating because of its cheapness, but it will prove more convenient and we hope to build up a larger market for our gas on that account.

"In the Southern cities gas is used largely for house heating and in Portland, Ore., the local gas company has made considerable progress in popularizing it for that use."

Why Research?

By F. Paul Anderson

I assume that you will not be interested in hearing so much about research as in hearing something about those ideals that are related to it in general. I was very much struck with the program of this convention. It is typical of the ideals that are expressed everywhere in this country by men who are accomplishing something.

Research, in my opinion, is seeking after truth. The business man who succeeds is the one who does research work every day. This country is perhaps doing more in the way of developing suggestions and ideals that are basic than any country on earth.

The amount of research work that is done in this country today is beyond conception. The General Electric Company is spending $3,000,000.00 yearly, the Western Electric Company is spending $9,000,000.00 on the telephone. Whenever any great work is to be taken up men find out the essential details necessary to make it go. Research enters into everything we do.

The work on warm-air furnaces that is being done at the University of Illinois has been referred to several times, and I am glad to speak of it. You have been putting in warm-air leader pipes year after year, following closely the methods of your fathers or employers. Prof. Willard determines how many B. T. U. at a certain temperature, will pass through a square inch of leader. He finds, for instance, on the first floor that 111 B. T. U. at about 175° F. would pass through each square inch. In other words, 1000 B. T. U. will pass through 9 sq. in. The other side of the equation is very simple.

It was found that eighteen-thousandths of a B. T. U. is necessary to raise the temperature of a cubic foot of air one degree. To raise it seventy degrees would require seventy times eighteen-thousandths, which, multiplied by 800, would give 1000 B. T. U.

It was found that 23 B. T. U. pass through a square foot of wall a minute. This multiplied by 70, and again multiplied by 60, represent the number of B. T. U. that would come through in an hour.

1 2/10 B. T. U. will come through a square foot of glass per hour. Multiply this by 70, and then by 12—it is a question of finding a multiplier that will make 1000.

These equations are based on facts that have been determined in a laboratory under the hands of a master. The cubic feet in this room, divided by 800, plus the number of square feet of wall, divided by 60, the number of square feet of glass in this room, divided by 12, would represent the number of B. T. U. lost. How do you supply that loss? Multiply it by 9, and you have the area of the leader.

There are a number of other questions coming up that will be of vital interest to the sheet-metal contractor. The question of whether a riser should be 6 in. or 4 in. is to be settled. It may be an economical thing to use a 6-in. riser, but it takes a long time to make the builders take out a two by four, and put in a two by six, but it is one of the things that will eventually come.

The laboratory is conducting a series of experiments to determine the amount of leakage through windows and openings in buildings in general. These values will be of great service in determining the number of air changes in the building in an hour.

The question of ozone has been intangible for years, but undoubtedly possesses great merit. Dust in the atmosphere has concerned owners of buildings for years. Instruments have been devised that will measure dust. And with these investigations of dust eliminators will be made.

Perhaps the most important investigation carried on at Pittsburgh is a study of the effect of atmospheric conditions on the comfort and health of man. The character of air, amount of humidity, relative amount of humidity to temperature is important. More than 500 persons have been used in these investigations. In some of the great factories of the country units of 500 persons at a time will be investigated as against 500 under another condition. The amount of production under these variable conditions will be given. All this leads to one thought—that these laboratories are accomplishing something that will be of untold value to the manufacturer, no matter what his business may be.—*From an address before the National Association of Sheet Metal Contractors.*

Program for Fifth Annual Convention of American Gas Association

A number of papers on heating subjects will be presented at the forthcoming convention of the American Gas Association, in Atlantic City, October 15-19. As was the case last year, headquarters will be on the Steel Pier, where the exhibition space comprises 27,000 sq. ft. Technical sessions will be held in the convention hall, at the ocean end of the pier. Two papers on house heating will be presented, one by G. I. Vincent, manager of the Syracuse Lighting Company, Syracuse, N. Y., and the other by E. D. Milener, of the Consolidated Gas, Electric Light & Power Co., of Baltimore. One of the most important papers, from the heating standpoint, is by T. M. Foulk, of the Denver Gas & Electric Light Co., on "Denver's House-Heating Experience," detailing the results of the first year's operation of the scheme being tried out in that city to heat houses with gas on a wholesale scale, pressure being used in the gas lines to obviate the need of large mains.

Correspondence

Proper Positions of Air Intakes and Outlets.

EDITOR HEATING AND VENTILATING MAGAZINE:

Recently a dispute came up regarding the best positions for a fresh-air intake and discharge outlet.

Because of space limitations the flues are separated only by a 12-in. wall in a common shaft and are carried to the top of a four-story building, as shown in Fig. 1.

My contention was that the exhaust air outlet should be carried about 10 ft. above the fresh-air intake as a precaution against contamination of the supply, basing my claim on the fact that the exhaust air is always warmer than the outside air and will naturally rise upward. The construction I proposed for the roof shaft was as shown in Fig. 2. The other party said that the openings for intake and outlet should be the reverse, as in Fig. 3.

Please be kind enough to explain to me which is the correct method and why.

For the sake of clarity, the entering air to the building will be herein named "supply" and the duct for same will be known as "supply flue." The air leaving the building will be named "vent" and the duct for same will be known as "vent flue."

The sketches indicate that there will be both a supply and a vent fan. The velocity of the air in the vent flue will, therefore, be much higher than would likely be the velocity with gravity circulation, hence the air will be diffused upward and outward more rapidly when leaving the flue than would be the case if the circulation was dependent upon gravitation.

The difference in the temperature between the surrounding atmosphere and the air leaving the vent flue will also have an effect on diffusion. It would, therefore, be better to project the vent flue above the supply flue, and the higher it projects the better it will be. The wind blowing against or into a flue will have a greater effect than possibly any other element. If the flue projects high above the intake, the wind is likely to remove the air discharged from the vent flue to a distance so remote that there would be no chance of any of it getting into the supply ducts.

Unless the toilet rooms are ventilated into the vent flue (which should never be permitted) no serious objections can be proven by anyone whichever system is used. Careful tests of the quality of the air leaving the average building show that it is a good and in many cases it is even much better than the outside air. This is particularly true if the incoming supply passes through an air washer before entering the building, if said building is located in a dusty, smoky industrial or business district. In such localities the so-called "fresh outside air" is often more harmful than it would be if all interior air were recirculated through an air washer.—F. R. S.

Tests of Radiator Traps

EDITOR HEATING AND VENTILATING MAGAZINE:

In analyzing the recent tests on radiator traps as reported in THE HEATING AND VENTILATING MAGAZINE for August, 1923, I would like to point out that the type and size of radiator chosen for the tests puts such a flow of condensation through the traps that, in my estimation, they function as restricted orifices, instead of as automatic devices.

Varying loads have the same effect on the functioning of radiator traps as they have on any other mechanical device. It seems to me that this one item alone would explain much of the singular uniformity of the results.

Then the failure to give the size of the steam supply valve warrants the belief that much of the duty attributed to the functioning of the traps may really be performed at the inlet of the radiator by limiting the amount of steam that could flow into it.

Moline, Ill. J. M. R.

A Piping "Kink."

Where the scrap pile is called upon to eke out the contractor's stock room, he will find the following "kink" useful:

In removing close nipples there is always more or less damage done to the nipple from the strain of the wrench and this, in many cases, forces the nipple out of alignment to such an extent that it will not make a tight joint again. I have always kept the nipple round and true by screwing a female fitting on it before using the wrench. The fitting then acts as a protector and will not allow the nipple to be compressed to an egg shape by the pipe wrench.

When making or re-threading a close nipple, it will be found of great advantage to have a piece of scrap pipe nearly the full length of the coupling, threaded on one end. With the pipe held in the vise, screw your close nipple into a coupling as far as you can by hand. Then screw the coupling on to the long threaded pipe held in the vise until the end of the nipple is hard against the end of the pipe, inside the coupling. This serves as a lock nut and prevents the nipple from being turned tight in the coupling. After threading the nipple, you can easily release the coupling from the pipe with a wrench and the nipple from the coupling by hand.

This device can be laid away for future use and will be found of considerable value as a time saver. In removing or threading close nipples, lock the nipple as described above.—*C. Rye, Wesley College, Winnipeg, Man.*

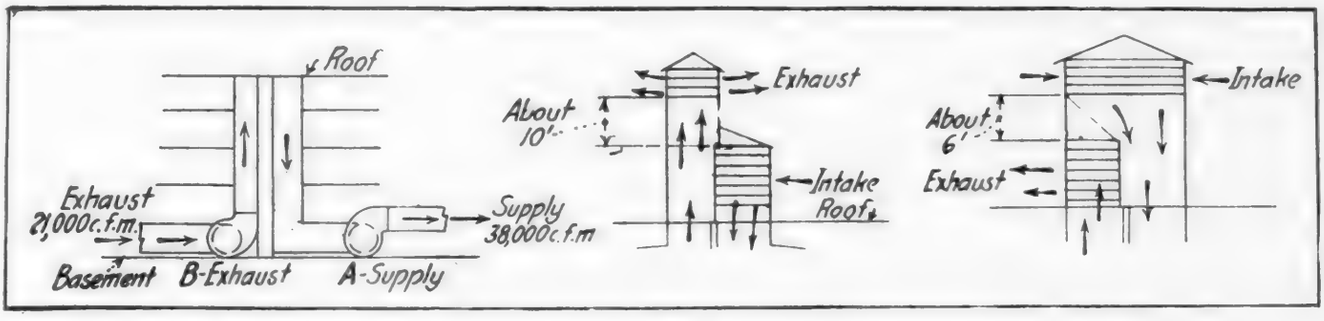


Fig. 1 Fig. 2 Fig. 3

Positions of Air Inlets and Outlets.

Thirty-five Years an Editor

Fred R. Low, editor of *Power*, who has so long been a familiar figure in that rôle in the mechanical engineering world that "the mind of man runneth not to the contrary," was tendered a testimonial dinner by his associates of the McGraw-Hill Company, at the Engineers Club, New York, recently. The occasion was chosen to commemorate the thirty-fifth anniversary of his editorship of *Power*.

Among the speakers were James H. McGraw and H. M. Swetland, who related some interesting reminiscences of the early days—they were the publishers of the paper at the time Mr. Low assumed the editorship. Secretary Calvin S. Rice, of the American Society of Mechanical Engineers, also spoke and told of Mr. Low's many services to the profession and to the society which have finally culminated in his nomination as president of the American Society of Mechanical Engineers for next year. A loving cup was presented to Mr. Low as a token of the affection and regard of his associates.

American Society of Heating and Ventilating Engineers

Nominations Out for New Officers

Nominations of officers for the American Society of Heating and Ventilating Engineers, as made by the society's nominating committee, are announced as follows:

For president, Homer Addams, New York; for first vice-president, S. E. Dibble, Pittsburgh, Pa.; for second vice-president, William H. Driscoll, New York; for treasurer, Perry West, New York. For members of the council: Dean F. Paul Anderson, Willis H. Carrier, J. A. Cutler, Walter E. Gillham, Alfred S. Kellogg, L. A. Harding, Thornton Lewis and H. P. Gant; for members of the Committee on Research, Homer Addams, Dr. E. Vernon Hill, Alfred S. Kellogg, J. R. McColl and F. R. Still. In the case of the nominees for the Committee on Research, all of the members whose terms are expiring have been renominated.

The Nominating Committee is composed of Samuel R. Lewis, chairman, Chicago; E. P. Bradley, E. C. Evans, J. D. Hoffman and W. S. Timmis. Election is by mail ballot, the ballots being opened and counted on the opening day of the society's annual meeting in January.

Committee Appointed to Consider Report of New York State Ventilation Commission

A special committee to consider the report of the New York State Commission on Ventilation, which has created such a stir in ventilating circles, has been appointed by President H. P. Gant, with C. L. Riley as chairman. The other members of the committee are: Dean F. Paul Anderson, Professor F. E. Giesecke, Dr. E. V. Hill, John Howatt, Allen Hubbard, D. D. Kimball, J. H. Kinealy, J. R. McColl, F. D. Mensing, Perry West and Professor A. C. Willard.

Care was taken to exclude from the make-up of the committee anyone who was interested commercially in any product used in connection with heating and ventilating systems in schools, so as to give complete assurance to the public of an unbiased opinion. Many of the members, it will be noted, are past presidents of the society, while others have specialized in various phases of ventilating work.

In St. Louis the local chapter, acting upon the suggestion of Edwin S. Hallett, chief engineer for the St. Louis Board of Education, has appointed a committee which is making a very thorough analysis of the report of the New York State Commission on Ventilation. Different parts of the report have been assigned to various sub-committees and the results of their studies will be placed at the disposal of the corresponding committee of the society.

New Sheets for the N. D. H. A. Handbook

Included in the first set of supplementary sheets which have been issued for the National District Heating Association Handbook are sheets on water heaters, dealing with the size of traps required and the average square feet of brass surface required; storage tank capacities for various types of buildings; carrying capacities of steam pipes, with chart, contributed by J. C. Hornung, of Chicago; and steam service requirements for cooking. In addition several tables are included on steam requirements for various types of buildings. O. W. Kastens contributes a method of checking up a customer's steam consumption. Other tables, contributed by J. C. Hornung, deal with steam consumption at various outside temperatures, and pipe sizes for forced circulation of a water heating system. A special set of sheets is devoted to "Suggestions for the Economical Use of Central Station Heat," which is something the public has needed for a long time. It is stated that additional copies of this booklet may be obtained from the association at a low rate for distribution to consumers. That such a distribution will pay in dollars and cents is the opinion of those who have discussed the subject at conventions of the association and who have seen how a fuller knowledge, on the part of the consumer, of the heating company's problems and of the use of central station heat has led to co-operation and a better feeling all round.

Chemical Industries Hold Successful Exposition

The ninth National Exposition of Chemical Industries, held in the Grand Central Palace, New York, during the week of September 17-22, proved one of the most successful of its kind in the history of the industry. According to exhibitors' reports, more business was placed at the exposition this year than ever before.

Plans for the 1925 exposition are already under way. At a meeting of exhibitors, the advisory committee and management on September 20, preliminary arrangements for the 1925 show were made. The week of September 28 to October 3, 1925, and the Grand Central Palace, New York, were the time and place finally decided upon. Announcement was made at the close of the exposition on September 22 that over 75% of space on the first floor had already been contracted for in the 1925 exposition by present exhibitors.

Among the exhibitors were: Carrier Engineering Corporation, Newark, N. J., and the W. L. Fleisher Co., New York, air conditioning apparatus; American Schaeffer & Budenberg Corporation, Brooklyn, N. Y. indicating and recording instruments; Bailey Meter Co., Cleveland metering instruments; Beach-Russ Co., New York, vacuum pumps; Blackmer Rotary Pump Co., Petoskey, Mich., vacuum pumps; Bristol Co., Waterbury, Conn., indicating and recording instruments; Celite Products Co., Chicago, Ill., insulating materials; Crane Co., Chicago, Ill., valves, fittings, etc.; Fulton Co., Knoxville, Tenn., heating specialties; Grinnell Co., Inc., Providence, R. I., heating and piping supplies and air conditioning apparatus; Johns-Manville, Inc., New York, insulating materials; La Bour Co., Chicago Heights, Ill., vacuum pumps; Lebanon Machine Co., Lebanon, N. H., vacuum pumping outfits; Nash Engineering Co., South Norwalk, Conn., vacuum pumps; William Reed Engineering Co., Louisville, Ky., air filtering equipment; Sarco Co., Inc., steam specialties; B. F. Sturtevant Co., Hyde Park, Boston, Mass., air conditioning apparatus; C. J. Tagliabue Mfg. Co., Brooklyn, N. Y. thermometers and indicating and recording instruments; and Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., electrical devices, including electric welding machines.

In all there were 300 exhibitors.

Among the motion pictures shown were films on "Saving Coal in the Home," furnished by the Bureau of Mines; "The Story of Asbestos and Its Manufacturing," furnished by the Bureau of Mines and Johns-Manville, Inc.; and "The Story of Steel," furnished by the Bureau of Mines.

Apprenticeship Schools in New York

A night school for apprentices in the New York City building trades has been formed through the co-operation of the Board of Education of Greater New York and the New York Building Congress. Registration began September 10. Seventy classes will be conducted in ten school buildings. Similar courses are being arranged in other large cities, including Boston, Philadelphia, Cleveland and Chicago.

Deaths.

JOHN BIDWELL BLAKE, heating and ventilating engineer with the architectural firm of Holabird and Roche, Chicago, Ill., who died at his home in Lombard, had many notable installations to his credit, including the Loop Tribune Building, the University Club, Cook County Court House, City Hall, and La Salle Hotel. At the time of his death he was in charge of the electrical, heating and ventilating, elevator and plumbing departments of Holabird and Roche, with whom he had been connected for 25 years. Mr. Blake was 59 years old and was a graduate in mechanical engineering from the University of Illinois. During the war he served with the Construction Division of the army and had the rank of major.

A. M. EVERHART, vice-president and plant manager of the Niagara Radiator & Boiler Co., North Tonawanda, N. Y., died at his North Tonawanda home of septicemia.

Types of Fuel-Oil Burners for Household Use

Previous articles in this series are: 1—*Combustion Fuel-Oil Burners, Sept.* 1922; 2—*Kleen-Heet Oil-Burning System, Oct.*, 1922;—3—*Ray Rotary Fuel-Oil Burners, Nov.* 1923; 4—*Victor Automatic Oil Burner, Dec.*, 1922; 5—*Rotary Oil Burner, August*, 1923; 6—*Boston Safety Automatic Oil Burner, Sept.*, 1923.

VII—The Williams Oil-O-Matic Burner.

The system of fuel-oil burning, known as Williams Oil-O-Matic Heating, is frankly an innovation in the art and its development has created a new type of burner, namely, a combination of mechanical and low-pressure atomization. It has been sought through this design to reduce power consumption.

The problem which confronted Oil-O-Matic engineers was to produce an automatic burner which would burn successfully the heavier and cheaper grades of oil, such as fuel-oil. The results, the company states, are that the type of burner here shown will burn effectively any oil that will flow through a 1-in. pipe.

In the Oil-O-Matic burner the oil is burned as a liquid suspended in air. This is accomplished through an atomizing pump and nozzle. The pressure required is 2 lbs. per square inch. By atomizing the oil, it is stated, the carbon deposits are eliminated, as there are no vapors to develop such residue.

Automatic operation of the system is secured through the use of a thermostat located in one of the main rooms of the building to be heated. The thermostat is connected to a motor which drives a metering pump, atomizing pump and fan. When the thermostat acts it also opens an automatic gas valve and ignites the gas by means of a spark. This valve remains open only long enough to light the oil, and then closes. In this way gas is used only for a short period each time the burner starts.

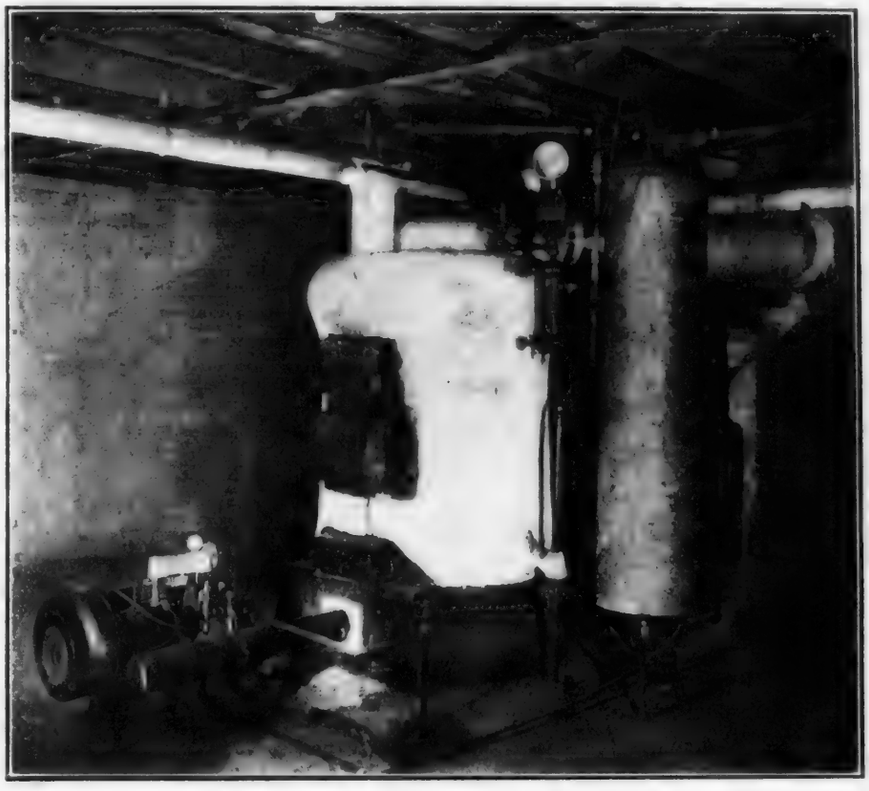
Care has been taken to provide the necessary safety devices. For instance, a safety cut-off is included to automatically shut off the burner when no hot gas passes up the smoke pipe.

The Oil-O-Matic system is made in two sizes for domestic service, a 1200 size, designed to take care of any building which requires not more than 1500 sq. ft. of direct radiation, and an 1800 size which is capable of handling up to 4000 sq. ft. of direct radiation.

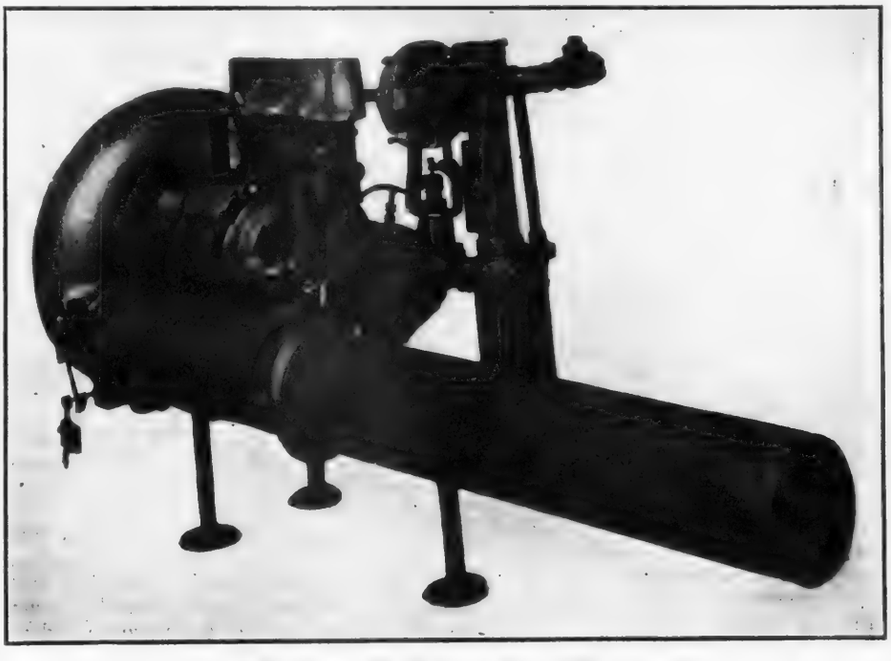
The company also manufactures a power burner that is capable of developing 250 B. H. P. The combinations for this outfit make them adaptable for a wide variety of types of power installations.

Oil-O-Matic engineers, it is just announced, have also developed a special oil-burning boiler which will shortly be placed on the market under the name of the Oil-O-Matic boiler. This boiler, it is stated, involves new principles of design and some unique features of construction. The efficiencies obtained, running up as high as 85%, have led the company to build this boiler which is adaptable only for oil burning.

The Oil-O-Matic system is manufactured by C. U. Williams & Son, Bloomington, Ill.



Typical Installation of the Williams Oil-O-Matic System.



The Williams Oil-O-Matic Fuel-Oil Burner.

Current Heating and Ventilating Literature

RADIATOR RATINGS. Standard Ratings for Radiators, Boilers and Complete Installations, A. H. Barker. Domestic Eng. (British). Vol. 42, No. 48, Dec. 1922, pp. 242-247. Difficulties of tests, such as determining amount of surface, maintaining uniform temperatures, size of radiators for given duty, and similar difficulties in boiler tests.—30¢.

The Reversible Fan Housing as a Contribution to Standardization and Efficiency

By Arthur L. Greene

A prominent engineer recently remarked that "this is an age of movements." A more comprehensive characterization could be made by adding that it is to an equally marked degree the age of standardization, economical methods of operation and simplification of parts. The "age of movements" has already revolutionized our mode of living of but a decade ago and has, in most instances, made for improved conditions. Not the least important of the advances made has been the development of mechanical ventilation, the scientific regulation of humidity and temperature as applied to the home, factory and school; the increasing stress placed on health campaigns for pure air. The results of laboratory research, in some cases, have outdistanced the mechanical improvements made in ventilating systems and apparatus.

A product distinctly in line with the new age is a recently-developed centrifugal ventilating fan, combining such features as interchangeability of parts, self-contained bearing support and a system of rivetless construction for fan housings. This improved construction has been brought out by the Buffalo Forge Company, Buffalo, N. Y., and has been applied to its line of fans, including the Niagara Conoidal, Turbo Conoidal, Duplex Conoidal and steel pressure blowers, in all sizes from No. 2 to No. 6, inclusive, and for capacities up to 14,000 cu. ft. per minute. The cost, it may be added, for the new construction, is equivalent to that of a fan with fixed discharge and stationary hand.

Both the large and small manufacturer employing forced ventilation in his plant has had occasion, perhaps, at one time or another to change the location of part or all of his ventilating apparatus, such as fans, inlet and exhaust ducts, heating coils, etc. The actual process of changing, however, has often brought forth difficulties of an unexpected nature, difficulties requiring substitution of a right-hand fan for a left, or perhaps an alteration in direction of discharge from a top vertical to a bottom horizontal. With the fixed position of outlet, the only remedy left the manufacturer, under the circumstances, was to discard the relic of overnight and purchase a new one with the desired hand and discharge. Needless to say, the expense incurred and the necessary time lost in shipment have been no slight causes making for a disgruntled customer.

Fig. 1—Reversible Fan Housing Brought Out by Buffalo Forge Company.

The new Type H fan, with its reversible housing has been designed to overcome this difficulty. In brief, these fans are adjustable for any discharge in any angle of a vertical plane and, in addition, can be made for either a right or left-hand, as the particular installation may require at any one time. The features making this possible lie in the construction. The Type H fan is made of three easily-assembled parts, as differentiated from the former one-piece construction. As can be seen from the illustration (Fig. 1) the fan housing consists of two demountable side cover plates, or standards, and the shell. In one side is an unobstructed inlet, while the other supports the shaft and bearings. To change the hand of the fan it is only necessary to remove the assembly bolts connecting the standards with the shell, shift these cover plates, thereby reversing the position of inlet and pulley, and rebolt.

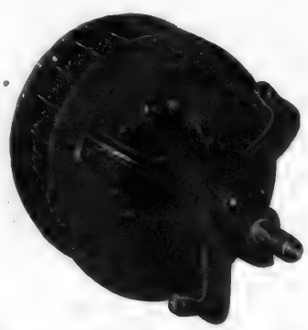


Fig. 2—"T" Bearing Used with Reversible Fan Housing.

It is the claim of the manufacturers that such procedure can be gone through with one of the smaller fans, such as a No. 3 or No. 4, in one hour's time. For changing direction of discharge it is only necessary to loosen the assembly bolts in the ring of each side plate and take out two reinforcing bolts, then revolve the housing until the discharge points in the desired direction.

These fans, generally speaking, are only reversible for three positions, no bottom horizontal being feasible because of closeness of bearing center to floor. If this discharge is necessary, however, the base can be raised by putting it on a temporary platform of some kind, sufficient to allow clearance for swivelling the discharge to this position.

METHOD OF CONSTRUCTING FANS WITH RIVETLESS HOUSINGS

Closely allied, but independent and unrelated as regards practical usage, is the so-called rivetless housing system. The method of construction is quite simple. The steel scroll sheet, after being cut to size, is stamped along the edges in a reversed U-shaped scarfing while the two plates forming the side walls of the shell are punched with holes corresponding in size and spacing to the scarfing or projections on the edge of the scroll sheet. Assembling of the housing then consists of fitting each side of the housing plates to the projections in the scroll plates and expanding these projecting edges to make a tight fitting union. By use of this method, all rivets are eliminated in assembling, the inside of the fan housing presents a perfectly smooth surface with no frictional points, the efficiency of the fan, through elimination of internal friction for the air and the making of a tighter fitting union at the joints, is increased, time of construction and assembling is reduced and standardized production methods are insured in the cutting and laying out of the plates.

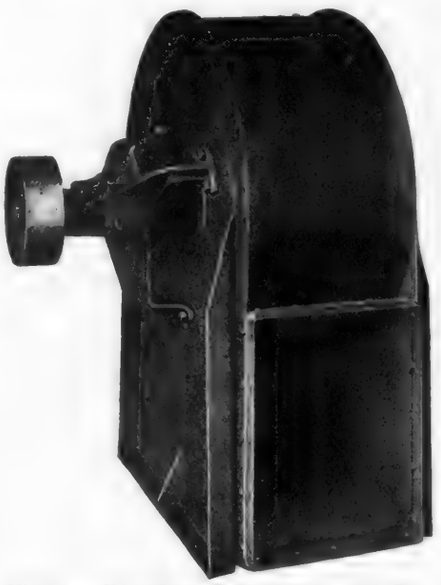


Fig. 3.—Rivetless Construction of Reversible Fan Housing.

RESULTS OF TESTS

Tests recently conducted of the new housing construction afford evidence of its durability. A No. 3 Niagara Conoidal fan, assembled with the rivetless system, was fitted out with blast wheel and bearings complete. It was then dropped from a crane 35 ft. above the floor level, falling two times on concrete surface and once on a wooden floor. Examination of the fan housing immediately following showed the bearing arms broken and the fan housing dented. The expanded projections of the scroll sheet effecting the

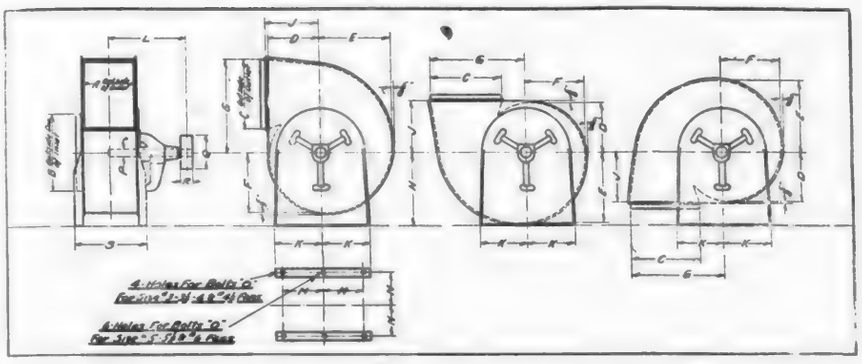


Fig. 4—Different Positions of Outlet Obtainable with New Reversible Fan Housing.

union with the side plates were forced apart some 4 in. surrounding actual point of contact, but in no instance were these projections broken off or in such condition as to require new plates.

USEFULNESS OF TRIPOD BEARING BRACKET

Equally important in development of the new so-called Type H fan has been the introduction of the tripod bearing bracket to take the place of the cast-iron bearing stand with a separate base. This bearing, as the name implies and as shown in Fig. 2, is in the shape of a bracket with three arms of "T" section and is attached direct to the fan housing. a strap ⅜-in. by 1½ in. forms a binding band on the inside of the housing for the tripod and reinforces the sides. The bearing itself consists of two split bearings bored and reamed, with bronze bushings inserted. The fans on which it is used are fitted generally with Type "D" wheels and take standard Type "D" capacity tables. All shafts are ground and the liners reamed to exact size. The bearings are cast as one unit to secure close alignment; the bearings are accessible for repairs and inspection; the weight, in consequence of having a less cumbersome casting is considerably reduced; and, important from the viewpoint of simplicity of construction, the tripod casting consists of but one piece whereas in the older type, the bearing stand is composed of eight separate castings and parts.

ELIMINATING INLET BEARINGS

A feature considered of special desirability possessed by this fan lies in the combination effected of overhung pulley and wheel type, eliminating thereby the necessity of a bearing in the inlet. The avoidance of this inlet bearing is looked upon as a very distinct advantage particularly where a connection is used on the suction side of a fan.

In connection with this principle, it is interesting to note a section of the Code Report, issued recently by the Advisory Committee of the Industrial Committee of Wisconsin, and entitled "Motors Out of Air-Ways." It reads as follows:

"Motors, engines and similar motive power and apparatus for fan drives, shall be kept out of fresh-air-ways.

Notes (a) All bearings should be kept out of fresh-air-ways whenever possible. Single inlet overhung fans are generally preferable. Bearings which cannot be kept out of fresh-air-ways should generally be of the grease or hard oil type."

OVERHUNG PULLEY FEATURES

The overhung pulley feature of this fan is of advantage in changing pulley sizes. These fans are essentially for pulley-driven jobs, but they can be made for direct motor drive as well by placement of a sub-base for the motor and connecting it to the shaft by means of a flexible coupling. The tripod bearing has a large oil reservoir, a hinged cover plate over the oil ring, and a drain plug and overflow opening with cover. The side sheet is clamped against the housing with clips which may be loosened by slacking off the bolts, just as with the planing mill exhausters.

A test run at the plant of the Buffalo Forge Company with one of these tripod bearings installed on a planing mill exhaust fan and operating at about 4 in. static pressure, as compared with the ½ to ¾ in., which is the usual service for ventilating fans, brought out no weakness or inefficiency in the bearing during one year's steady operation; in fact no trouble of any kind was experienced.

A New Type of Glass Window Ventilator

Those who have subscribed to the "open-window ventilation" idea will find their wants anticipated in the Thomas A. Jenkins glass ventilator, manufactured by the Thomas A. Jenkins Mfg. Corporation, 66 Jefferson Avenue, Jersey City, N. J. This ventilator which is in the form of glass louvres, is adaptable to thermostatic control, in much the same way as the louvres of a duct system. The glass used may be transparent or opaque, moulded, blown or cut, fixed or adjustable. The company also supplies a dust-filtering fabric which can be laundered. These ventilators can be used, it is stated, without altering the window construction and have the advantage of providing an opening through the entire window, instead of only half. They are also adaptable, in doors, in partitions, panels and skylights.

In the latest construction of these ventilators, the lights or plates of glass are 5 in. wide. Each light is insulated in rubber and the rubber rests on a metal retainer. The retainers have four adjusting screws for the purpose of adjusting the glass lights so that they will lap tight. The lap is ¾ in.

The retainers which carry the glass plates revolve in "Bound Brook" oilless bearings and are controlled by standard brass gears. The frame construction is of metal to suit conditions. However, the metal generally used is aluminum, highly polished. All mechanism is concealed but is accessible by removing face plates. The glass plates themselves can readily be replaced.

Hinges permit the sash to swing inward, so that the entire window construction, including jambs, sill, etc., is accessible for cleaning. The glass lights are designed to revolve synchronously and the general limit of movement is 90 degrees.

In connection with the ventilators, the company recommends the use of a duct

Jenkins Glass Ventilator with Detail of Louvres.

equipped with fixed glass plates to prevent down-drafts. Glass plates are recommended for their sanitary features as well as for their transparent qualities. The manufacturer reports a number of notable installations including those in the plants of the Air Reduction Sales Co., Jersey, Jersey City; Davis Baking Powder Co., Hoboken; and in the Rehabilitation Clinic of the New Jersey State Board of Hygiene.

Deaths.

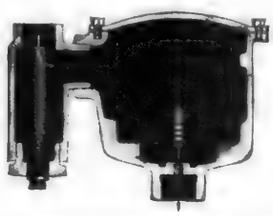
HENRY NIEMES, who died suddenly on the golf course of the Western Hills Country Club, in Cincinnati, had been engaged in the heating contracting business for the past 31 years. He was 55 years old and was a life-long resident of Cincinnati.

A New Blast Trap

A new blast trap, intended to combine the desirable features of the thermostatic and bucket or float traps, has been developed by the Hoffman Specialty Co., Waterbury, Conn., and has been placed on the market under the name of the No. 12 Hoffman blast trap. Through the combination of a float and thermostatic member, the trap is designed to function under all possible conditions present in a steam system. In order to prevent "air binding" of the trap, the thermostat is arranged to hold the vent port wide open until steam reaches the trap and, through float action, to release the water, regardless of its temperature, immediately upon its arrival at the trap.

The moving parts comprise only the float and thermostat. The thermostat is placed in a sleeve passing through the center of the float, thus permitting the circulation of air, water and steam past the thermostat, and causing it to function as required. To maintain the discharge port wide open until steam contact causes expansion of the thermostat, the thermostat is held in a cage, which rests on the seat plug. The cage also supports the float. On the inside of the body casting are four lugs for guiding the float and holding it centrally with the discharge port.

Cast-iron is used in the construction of the body, while the renewable valve seat is of bronze. The float is a heavy



No. 12—Hoffman Blast Trap.

drawn-brass shell, the valve pin of Monel metal and the thermostat of special Hoffman diaphragm composition. Inlet and outlet connections are tapped for 1-in. pipe.

On the inlet side of the trap is a strainer having an iron body, with perforated brass screen mounted in a brass bushing, by means of which the entire strainer can be removed for cleaning. The bushing also is tapped for a plug which permits "blowing down" the strainer.

In operation, the normal position of the discharge port is wide open for the discharge of air when steam is first turned on. This position is maintained until steam reaches the trap, when the thermostat operates to close the discharge port and permit the passage of steam in the discharge line. Should condensation having a temperature approximately 10° less than that corresponding to the steam pressure flow into the trap, the thermostat will contract and permit the release of condensation, closing the port partially if condensation continues to dribble into the trap or entirely, if the condensation flow is not continuous.

The usefulness of the float comes in when a slug of water beyond the capacity of the thermostat, reaches the trap. In that case the float is designed to lift the thermostat away from the valve seat and permit a free discharge of the condensation. As soon as the "slug" is passed, the float lowers the thermostat towards its seat and the trap then resumes its normal thermostatic action.

It will be seen that the nominal capacity of the trap is independent of the water temperature, so that with increase there will be increase of capacity. There is, however, a limit to the capacity-pressure ratio, which occurs at pressures above 20 lbs. Above that pressure, with the thermostat expanded and discharge port closed, the float has insufficient power to lift the valve pin from its seat until a temperature drop takes place. When that happens, the valve partially opens, after which the float comes into action to open the valve port wide. Action of this sort, it is pointed out, can only result in a reduction in capacity because of the slow opening of the discharge port.

For pressures up to 20 lbs., the trap capacities range from 400 lbs. of condensation per hour at 1 lb. pressure to 960 lbs. condensation at 20 lbs. pressure. As already indicated, while the trap will operate under higher pressures, the capacity will always be less than that under 20 lbs., unless the temperature of the water is considerably lower than that of the steam.

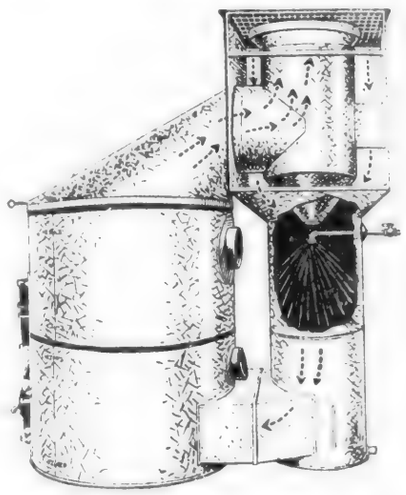
If water at a temperature of 20° less than the steam temperature flows into the trap, it will not cause any expansion of the thermostat and the discharge will then be continuous. Under such conditions, it is stated, the capacities will be approximately three times those specified above.

Special emphasis is laid on the point that in using the No. 12 trap on blast coils or Vento heaters, it is important to know the condensing power of a square foot of surface. This, of course, is primarily dependent on the fan speed and temperature of the air.

The Hydroaircirculator

A recent attempt to solve the humidity problem in the home is illustrated in the accompanying drawings of the Hydroaircirculator which has been developed by D. Handelan and is being marketed by the Handelan Mfg. Co., 4901 Thirty-ninth Ave., So., Minneapolis, Minn. When used in connection with a warm-air furnace, the Hydroaircirculator is installed in the return air duct, discharging a water spray which acts to remove dust as well as to moisten the air. Regular city water pressure is used and the water after being sprayed is drained to the sewer.

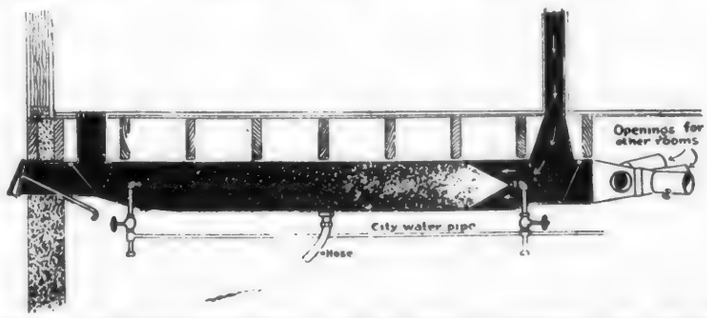
Another application of the Hydroaircirculator is in connection with an air duct,



Installation of Hydroaircirculator in Warm-Air Furnace.

so arranged with two register openings in a given room that the spray acts both as an air moistener and as an air circulator. This arrangement can also be used with outside ventilation. By installing a spraying device at each end of the duct, the air can either be expelled or fresh air drawn in by reversing the spray. In this manner the air can be recirculated when desired in the winter time and outside air drawn in and cooled in the summer time.

ASHTON MASTER PRESSURE AND MASTER PILOT GAUGES AND ASHTON IMPROVED PRESSURE AND VACUUM RECORDING GAUGES AND RECORDING AND INDICATING GAUGES; ALSO ASHTON IMPROVED DEAD-WEIGHT PRESSURE GAUGE TESTERS, all products of the Ashton Valve Co., 161-179 First St., Cambridge 41, Boston, Mass., have new features about them which are described in circulars issued by the company. In the case of the recording and indicating gauges these are now equipped with a capillary glass pen designed to overcome the troubles commonly experienced with recording gauge pens. Size of each circular 6 x 9 in. Pp. 4, each.



Arrangement of Hyroaircirculator in Air Duct to Moisten and Circulate Air

Business Moves Upon Slightly Lowered Levels

Autumn Season Starts Satisfactorily—Market Remains Healthy

Especially Prepared for THE HEATING AND VENTILATING MAGAZINE.

By L. W. Alwyn-Schmidt

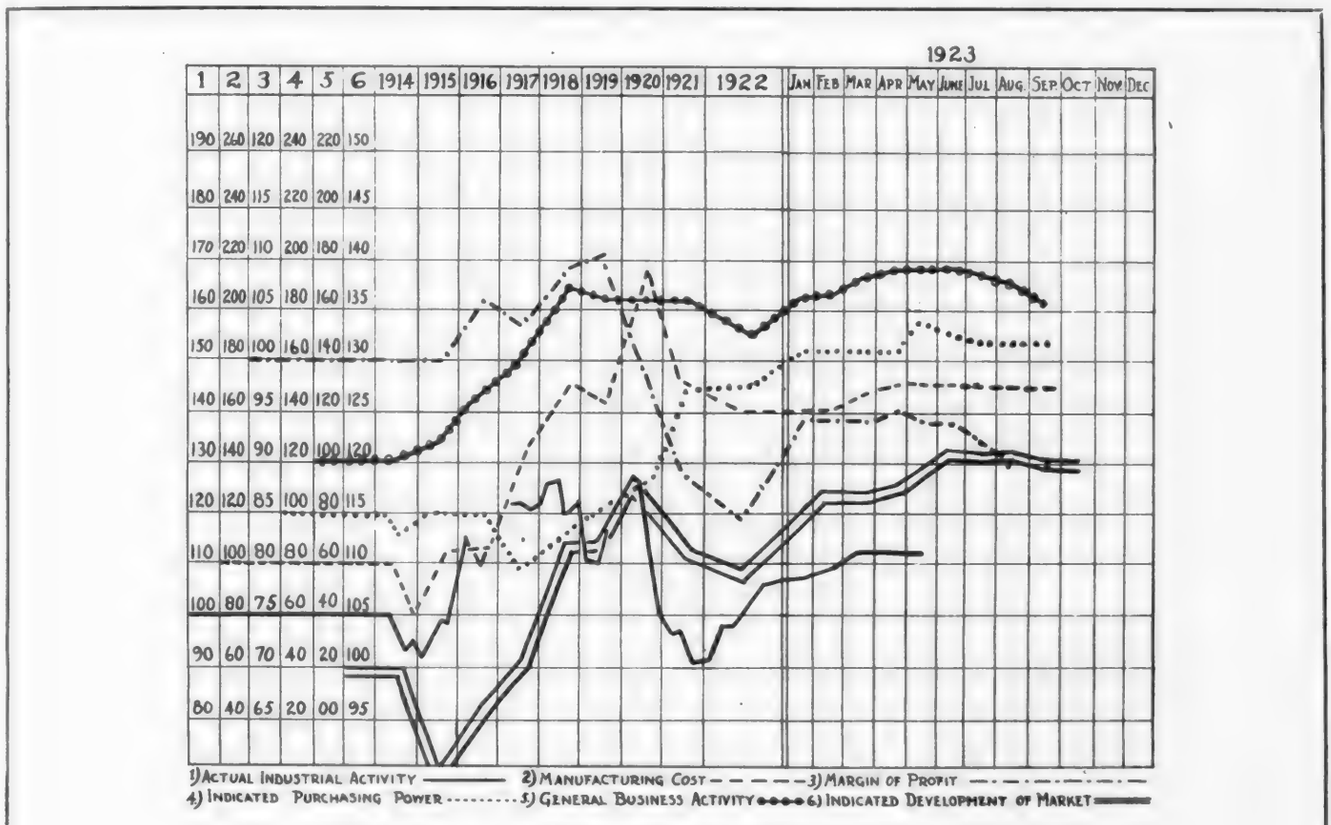
American business after having withstood for nearly a year the pressure from abroad begins now to feel the reflexes of continued disturbed conditions of Europe, and our big industries show a tendency to go ahead very slowly indeed with plans for further expansion. This, in turn, has had a marked effect upon the wholesale and retail trade where it is generally realized that the prosperity of the early spring and summer has made room for a period where only earnest work and careful planning will lead to success. But never was our country better equipped to meet the exigencies of such a situation. The war has taught us the advantages of organization upon a national basis. It has also taught us the usefulness of exact information about the nation's requirements, supplies and available needs of production. So preparations have been made quietly for the ending of the spring boom. The descent to a slightly lower market level has been accomplished without any apparent discomfort. There is no reduction of wages, no forced selling of retail stocks, no lack of work. In fact, business has retained all the aspects of normalcy with a fine prospect of an early general improvement.

A very good sign under such circumstances is always continued stability in the general price situation, the cost of production and the rate of consumption. It is, therefore, very gratifying to see that almost all of these essentials to national prosperity have undergone little or no change. Where such changes exist they point rather to a strengthening than a weakening of the economic structure.

Retail and wholesale prices, as recorded by governmental and private agencies, have remained practically steady since the establishment of their present range several months ago, showing that the general consumer is perfectly willing to remain in the market at this level. The latter is also borne out by news from most retail centres telling about comparatively large turnovers in all classes of merchandise, allowing, of course, always for seasonal changes customary during the summer months.

This very satisfactory condition in the wholesale and retail markets most likely will continue all through the year. It will be made possible by the continued high level of purchasing strength of the wage earner and salaried man who have an ample surplus of their earnings left today for extra purchases. The prosperity of the earning classes, in fact, is one of the most encouraging signs of the present market constellation. It lets us expect a regular market for all staple merchandise and the luxury trades should feel its effect by a steady demand for better class, if not high priced, goods.

Manufacturers and large distributors will do well to keep an eye upon this feature of the situation. For the first it will mean a continued demand with a possibility of slightly better prices and a better stabilization of manufacturing profits which are still somewhat below the margin of safety. For the second it will serve as an indicator for his distribution policies. There exists an increasing desire of the consumer to get a dollar's worth for a dollar spent. Earnings have been invested temporarily or permanently in expectancy of lower prices. These having now materialized, savers begin to spend their money conservatively. The furniture, the build-



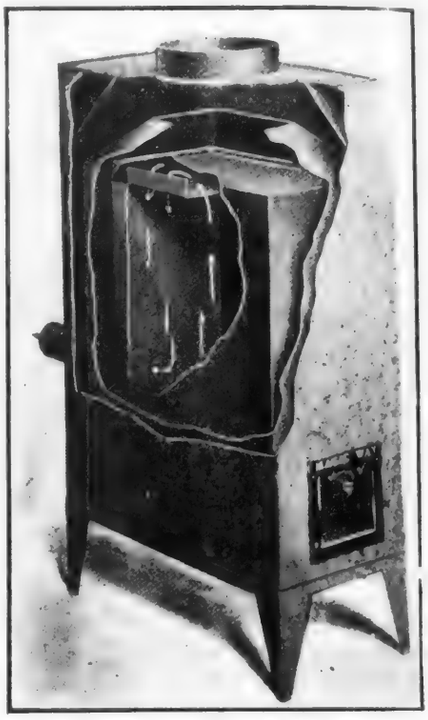
Analysis of Business Conditions at End of September.

ing, and similar industries will derive most benefit from this condition. The market favors all through the distribution of articles of more permanent value, and it is those which will produce the best sales. They should be featured prominently.

The prediction made several months ago that no sensational rise might be expected in the cost of production has come true. Wages, in fact, have experienced a slight decline in several branches of the national industry and there is no apparent cause to justify any immediate increase.

Industry and business, therefore, enter the autumn season under reasonably good conditions. True, we have against us the unsettled situation in the European market which has prevented us from maintaining the rate of progress made in the earlier parts of the year, but the short stoppage during the summer and consequent decrease in national industrial and commercial activity should have amply discounted by now any unhealthy tendency originating from that quarter. There is no evidence of previous overproduction; on the contrary, all indications point to a complete maintenance of the balance of supply and demand. The scale tips rather toward the producer as stocks apparently have remained below the average. The flow of merchandise between producer and consumer is normal and progresses at a sufficient speed to keep factories busy without overtaxing their facilities. No expansion is reported of the commercial credit system and there is a sufficient reserve of money in the hand of investors to take care of any possible addition of the national industrial equipment. The labor situation is pronounced as good, with little cause for friction between capital and labor.

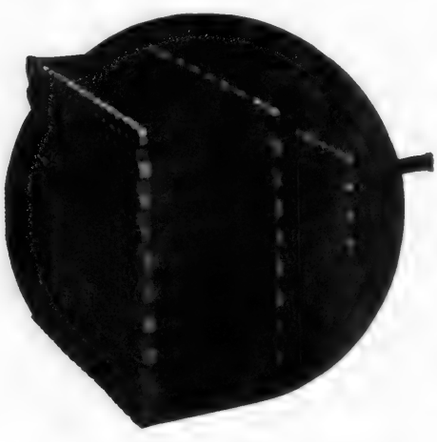
Under such circumstances manufacturers and distributors are justified to expect a satisfactory fall season, producing a healthy flow of business on price levels that will be sufficiently high to secure reasonable profits and continued employment of labor.



Individual Gas Heater Used with "Magic Way" System.

New Trade Publications

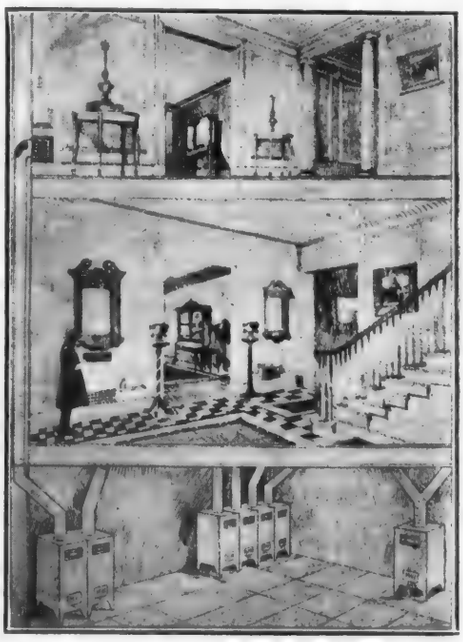
CARTRIDGE RADIATOR CORES for all makes of trucks and passenger automobiles and which are about to be adapted on an extentive scale for indirect heating work, are a product of the U. S. Cartridge Co., Lowell, Mass., which are described in recently-issued circulars. This radiator is an assembly of small, round, seamless copper tubes. The ends of the tubes are expanded in a hexagon shape. Then the tubes are laid in rows, one row upon the other. The ends are soldered together and the "core" is complete. Between the two surfaces formed by the joined ends of the tubes is the honeycomb of passages and channels for water. These passages, in connection with heating work, are the hot water or steam channels. The water or steam travels down between the tubes, from top to bottom. The air travels through the tubes from front to rear. When the sides of the core are closed with strips of copper there is no way for the water or steam to get out except at the top and bottom. The top and bottom tanks are soldered to the "core," and the "assembly" is placed in a shell. As is well known, the limitations in the use of copper radiators have been due in the past to weakness in construction. In the case of the Cartridge radiator coils, the fact is emphasized that the seamless copper tubes are formed from solid stock by cold extrusion which gives them exceptional strength. In one test, 250 lbs. of lead were suspended by a wire from a ring resting on a single tube, without damage. When additional 80 lbs. of lead were added to the load, the ring at the end of the wire gave way, but the core was not found to be strained.



New Copper Cartridge Radiator Which Is Being Marketed as an Indirect Heater.

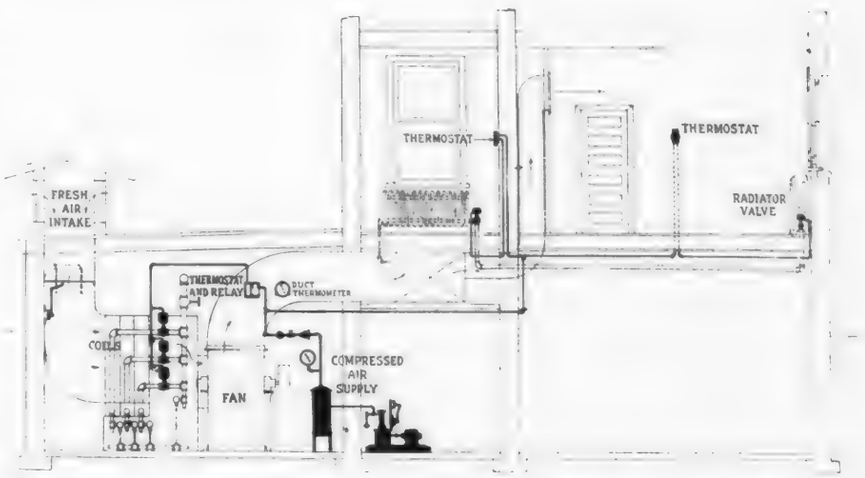
WEATHER VEIN, Vol. 3, No. 6, published by the Carrier Engineering Corporation, Newark, N. J., is devoted to the use of "manufactured weather" in connection with the packing of goods which need to be kept proof against moisture, as well as in a sanitary condition. The principal products discussed are those prepared by the Postum Cereal Company, of Battle Creek, Mich., whose packing departments are equipped with Carrier air conditioning apparatus. An interesting account is given of the different processes involved in the manufacture of Post Toasties Grape-nuts and Postum. The numerous illustrations accompanying the text show the processes going on, as well as the arrangement of the air conditioning equipment.

THE HOME OWNER'S WARMEST FRIEND is the title of a folder describing the "Magic Way" of heating homes by gas, a new heating system which is the product of the Unit System of Heating & Manufacturing Co., 1611 South Main St., Los Angeles, Calif. The principle of unit heating through the company's product is based on an individual gas furnace or heater for each room to be heated. By the use of electrically-operated valves, one of which is a part of each "Magic Way" unit, the temperature of any room in the house may be regulated by pressing a button. This valve not only turns on the heat by regulating the flow of gas but is also designed to regulate the heat to suit different wants. The operating mechanism of each valve, it is explained, is automatic in action. It operates at three positions, or stations—low, intermediate and high. The position of the valve and amount of



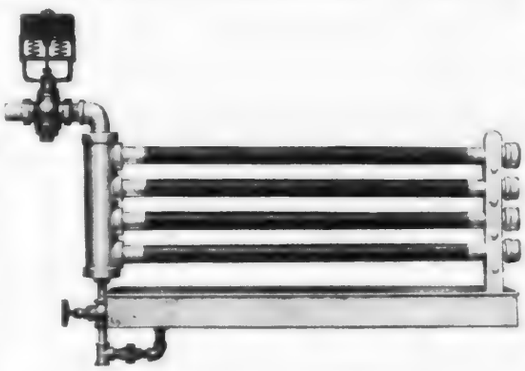
Typical Installation of "Magic Way" Gas Heating System.

heat being generated by any particular unit is always indicated by the electric signal lights on switches placed in each room and also on the master switchboard which may be located at any convenient place in the house. The current required for operating the valves may be taken from the regular house wiring, stepped down through a 20-volt transformer. The current used by the valves is required only during the instant of operation, and therefore represents a small charge. No installations are undertaken by the company until its engineers have made a careful study of the particular job. Detailed descriptions are included of "Magic Way" units, with separate views of the burners and electrical switchboard.



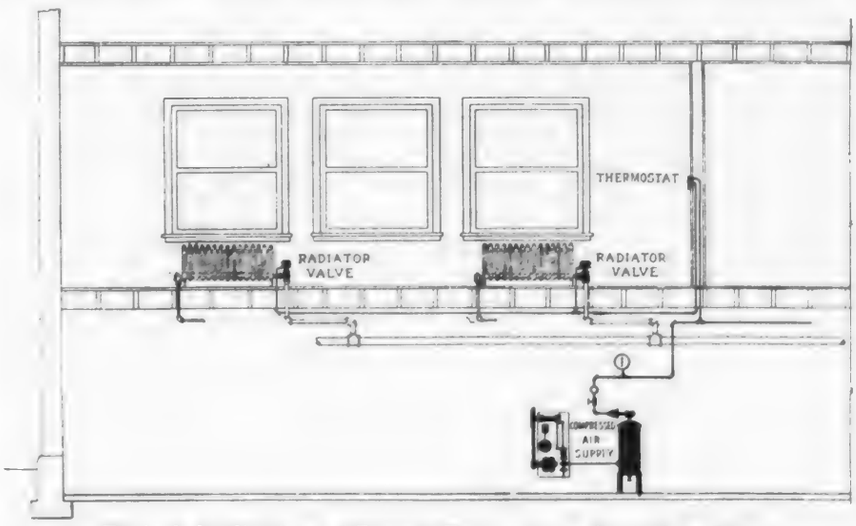
Typical Application of Power Temperature Control to Plenum Fan System of Heating and Ventilation.

VALVE WORLD for September, 1923, the monthly publication of Crane Co., Chicago, contains the Crane Business Survey giving business conditions as of August 25, summarized from telegraphic reports received from its various branches and offices. Taking the country as a whole the survey shows there is nothing very much the matter with business. General business in the Eastern zone is marked from "fair" to "good," with collections rather slow and building permits falling off. In the Southern zone, it is stated business is very good in New Orleans and only fair elsewhere. There is little unemployment in the Northern zone, while general business is satisfactory in St. Paul, Minneapolis and Duluth and collections coming in rather freely for this season of the year throughout the zone. Optimistic reports were received from all points in the Central zone with general business given as "fair" to "excellent." No change from last month is reported in the Western zone and Canadian business is reported as "slow" in the Eastern and Prairie provinces. *Valve World* itself contains numerous illustrations and a feature article on the new Sovereign Hotel in Portland, Ore.



Powers Steam Humidifier

POWERS TEMPERATURE REGULATION, featuring the products of the Powers Regulator Co., Chicago, Ill., is presented in a well-compiled catalogue recently issued by that company. The fact that these products represent the result of three decades of continued successful operation lends a special interest to the text matter. Charts in color give a graphic idea of the wastes involved in overheating and in the opening of windows to cool rooms. Attention is then directed to the unusual construction of the Powers thermostat which makes use of a volatile liquid which boils at ordinary room temperature. This liquid, being confined in the expansion disc, develops a pressure. This action is made easily understood by a comparison with the action of steam in a tea kettle. The liquid, of course, is hermetically sealed in the vapor disc which has flexible, corrugated sides to make them elastic. They are made of phosphor bronze. The vapor disc operates a vapor valve, controlling both supply and exhaust of the compressed air, thus acting as a reducing valve, being designed to give just the air pressure needed to correctly position the heat-controlling valves. The various types of Powers thermostat for different purposes are shown, together with the Powers radiator valves, damper motors, and the Powers graduated relay for controlling a number of valves. Different applications of these various units to fan ventilating systems and unit systems are included, supplemented by a very clear idea of their uses and operation. Other products included in the Powers system are illustrated and described, such as Powers air compressors, pneumatic switches and the Powers hygrostat and steam humidifier. The concluding pages are devoted to noteworthy installations of the Powers system. Size 8 x 11 in. Pp. 44.



Typical Application of Powers Temperature Control to Direct Heating System.

GRAVER WATER FILTERS of the horizontal pressure type, manufactured by the Graver Corp., East Chicago, Ind., are presented in Bulletin No. 501, just issued. The bulletin describes and pictures this filter and contains numerous tables and facsimile blue prints which, it is stated, will be sent, on request, to architects, engineers or others engaged in designing new plants or laying out equipment. The horizontal pressure filter is adapted to small municipalities, large outdoor swimming pools and industrial and manufacturing establishments when the quantity of water exceeds 250,000 gal. daily. Other products presented include the automatic coagulent feed tank, duplex pressure gauge, Graver filter strainer, and the sight wash glass.

STEAM TRAP SARCO, designed for use with laundry machinery, is presented to the trade in a new bulletin just issued by the Sarco Co., Inc. Woolworth Bldg., New York. Details as to sizes and types of traps to be used with laundry machinery and methods of piping recommended

by the company, are contained in the bulletin.

UEHLING CO² RECORDER, the product of the Uehling Instrument Co., Paterson, N. J. is explained in Bulletin No. 117, recently published by the company. The product is not a mechanical Orsat, the bulletin explains, having no movable parts and using no chemicals in liquid form. It operates on a simple scientific principle based on varying gas tension between two orifices. The equipment is designed to meet various power plant conditions.

MUELLER RECORD, for August, the periodical of the H. Mueller Mfg. Co., Decatur, Ill., contains an account of the annual picnic of Mueller employees, together with the address delivered that day by Adolph Mueller, president and treasurer of the company and numerous other items of news about Mueller employees. The annual meeting of salesmen preceded the picnic by only a few days.

MOLBY BOILERS are the subject of an illustrated two-color booklet issued by the Molby Boiler Co., New York, featuring its adjustable side grate which permits the burning of No 1 buckwheat anthracite coal. This small-sized hard coal always is plentiful, costs around $7.50 a ton against $13 to $15 for the larger-sized coal, and contains the same heat value, pound for pound, according to the Molby booklet. The new Molby boiler is designed, it is stated, to heat homes, large apartment houses or commercial buildings just as easily and just as successfully with the low-priced No. 1 buckwheat coal as with the larger-sized coal. The manufacturer states that the small coal is easy to obtain even during periods of shortage in the usual sizes of hard coal. Another feature of Molby boilers, to which attention is directed in the booklet, is the downdraft magazine-feed which, it is claimed, takes full advantage of the true principles of combustion. Fuel is added to the draft side of the fire and the air continually passes into higher temperatures. The boiler is made also in 26-in., 31-in. and 47-in. series. The latter two sizes have magazines on each side with two fires and a combustion chamber between the two water grates. The new Molby boilers are described as easy to operate, the magazines containing a 12-hour supply of fuel. They feed the fuel automatically down into the fire. The booklet contains tables showing sizes, capacities, dimensions and prices of the various types of boilers manufactured by the company. 4 x 9 in. Pp. 24.

HEAT BY RADIATORS is the title of an attractively printed booklet prepared by the National Trade Extension Bureau of the heating and plumbing industries, Evansville, Ind., and designed for use by contractors and dealers in heating supplies. Space is provided on the cover of the booklet for the imprint of the dealer's name. The books are recommended by the T. E. B. as a profitable and effective advertising medium. The booklets are printed in colors, amply illustrated and of envelope stuffer size. They contain much interesting and useful information to promote interest in modern heat by radiators. Official statistics point out, it is stated, that the most important factor, contributing toward the increased longevivity and well-being of the community, during the past two decades, has been the steady improvement in the methods of heating, ventilation and sanitation. Many practical suggestions for economy and comfort in house heating are made and home owners are urged to exercise the greatest of care in selecting and installing heating apparatus. Twenty-two rules for the design

Title-Page of National T. E. B. Booklet on "Heat by Radiators."

and care of house-heating systems are presented, together with convincing sales argument as to the advantages of radiator heat steam, vapor or water systems. Among the points claimed for radiator systems are their durability, the fact that such systems always increase the value of the property and have the greatest salvage value; also the claim that radiator systems consume less fuel to accomplish desired results and by reducing the fire hazard bring lower insurance rates. 3 x 6 ins. Pp. 12.

Operation of Temporary Heating Plants to Be in Control of Steam Fitters.

An important decision has been rendered by the National Board for Jurisdictional Awards in placing under the control of steam fitters low-pressure heating plants during temporary operation. This action was taken at a meeting of the board recently in Atlantic City, which was attended by a committee of the Heating and Piping Contractors' National Association, consisting of Frank W. Howard, Boston, and W. H. Driscoll, New York. A committee from the Chicago local association consisting of Messrs. Wray and Mangan, and steam fitters' delegates from Kansas City, Chicago, Pittsburgh and Jersey City, were also present.

It will be recalled that in 1920 a decision of the board had awarded this work to the stationary engineers. This led to so much argument that the subject was brought up for reconsideration.

The heating contractors at first took the position that the matter was one that should be left to the discretion of the employers, inasmuch as conditions on jobs of different characters and in different sections of the country would make it unwise to give complete control to any one trade. It was felt, however, by the board that its decision must be definite as between the two trades. The heating contractors then presented arguments in favor of the control being given to the steam fitters. The matter was considered by the board in executive session and the following decision rendered:

"Low-Pressure Heat (rehearing)—In the matter of the controversy between the engineers and the steam fitters on the question of low-pressure heat during the completion of the heating system while the building is under construction, jurisdiction shall rest with the steam fitters until the general test has been made and the work accepted by the owner or his agent."

A Useful Indoor Thermometer

Where a thermometer is intended for permanent use indoors, its usefulness is enhanced by confining the scale within the limits which ordinarily prevail. Such

Thermometer Especially Designed for Indoor Use.

a thermometer is easier to read and has the additional advantage of individuality. This particular type of thermometer, which is shown in the accompanying illustration, is being handled by W. C. Donnelly, 155 Remsen St., Brooklyn, N. Y. It is made with mercury or spirit meniscus.

When a higher price gets the contract

SOME Heating Contractors feel that they must use cheap radiator valves in order to meet competition.

But in hundreds of cases it has been proved that a bid—on Ideal Super-Packless Valves—makes the customer realize that the Heating Contractor is trying to make the job really high class.

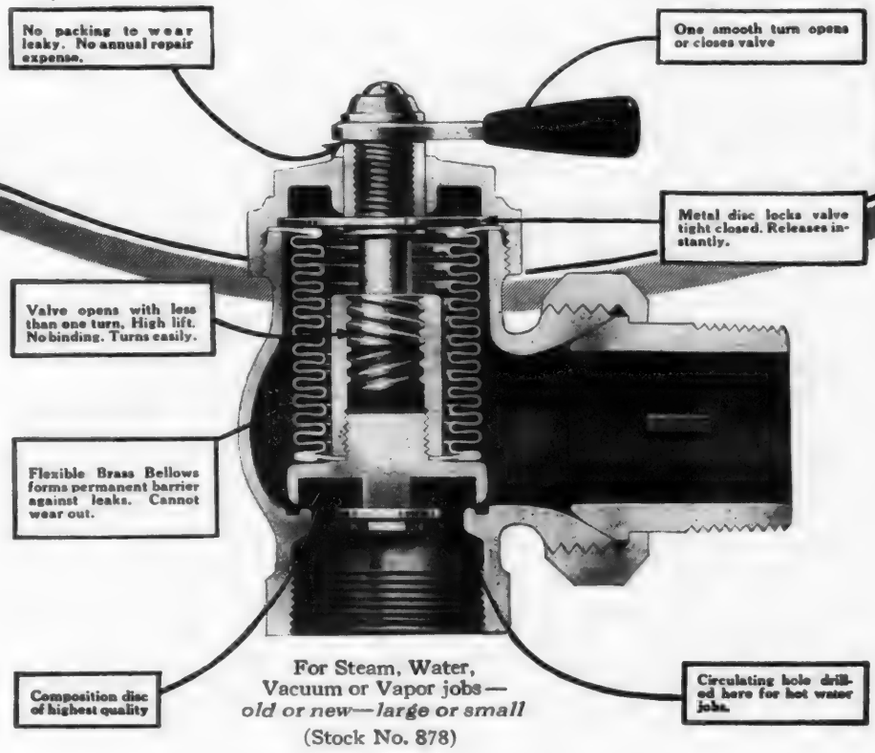
You can try this out for yourself without any danger of losing a contract. On your very next job, specify Ideal Super-Packless Valves, and then if necessary add an alternative bid on ordinary valves to keep you in line with competitors.

How to sell Ideal Super-Packless Valves

1. Install them instead of repacking when old-style valves leak.
2. Show a sample side by side with an ordinary valve. Then let your customer choose.
3. Include them on every bid and when necessary add an alternative bid on ordinary valves. This will either give you a preference for your work, or a chance to talk your bid

IDEAL SUPER-PACKLESS VALVE

Opened or closed with one easy turn


No packing to wear leaky. No annual repair expense.
One smooth turn opens or closes valve
Metal disc locks valve tight closed. Releases instantly.
Valve opens with less than one turn. High lift. No binding. Turns easily.
Flexible Brass Bellows forms permanent barrier against leaks. Cannot wear out.
Composition disc of highest quality
Circulating hole drilled here for hot water jobs.

For Steam, Water, Vacuum or Vapor jobs—
old or new—large or small
(Stock No. 878)

AMERICAN RADIATOR COMPANY

IDEAL Boilers and AMERICAN Radiators for every heating need

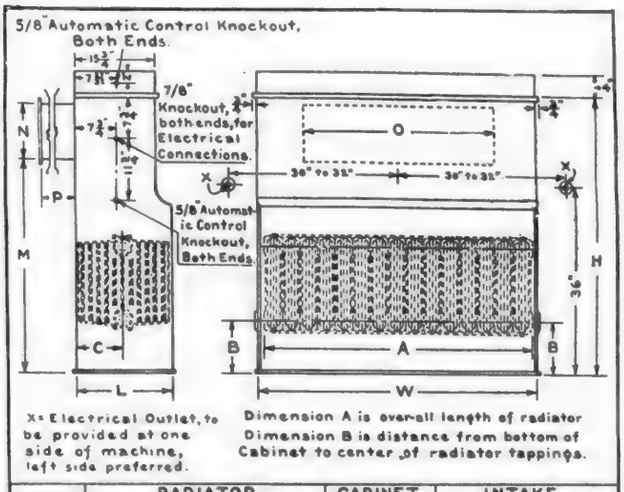
1807 Elmwood Avenue Dept. S 61 Buffalo, N.Y.

THE HEATING AND VENTILATING MAGAZINE—1123 BROADWAY, N. Y. CITY

PORTABLE UNIT VENTILATORS.

The Univent.

(Continued from Data Sheet No. 6—G)



X= Electrical Outlet, to be provided at one side of machine, left side preferred.

Dimension A is over-all length of radiator
Dimension B is distance from bottom of Cabinet to center of radiator tappings.

SERIES	RADIATOR A	B	C	Steam	Return	CABINET H	W	L	INTAKE M	N	O	P
501	51 3/4	14 1/2"	9 1/8"	2"	1 1/2"	33 1/8"	53 1/2"	18 1/2"	36 5/8"	11 1/8"	36 5/8"	Intake
502	50 3/4	"	"	"	"	"	"	"	"	"	"	furnished
503	52 3/4	"	"	"	"	"	"	"	"	"	"	18" long or
504	51 3/4	12 1/2	"	"	"	"	"	"	"	"	"	P. can be
505	50 3/4	"	"	"	"	"	"	"	"	"	"	cut to
506	52 3/4	"	"	"	"	"	"	"	"	"	"	not less
507	51 3/4	10"	"	"	"	"	"	"	"	"	"	than 6"
508	50 3/4	"	"	"	"	"	"	"	"	"	"	long on
509	52 3/4	"	"	"	"	"	"	"	"	"	"	job.
510	51 3/4	14 1/2"										
511	50 3/4	"										
512	52 3/4	"										
513	51 3/4	12 1/2"										
514	50 3/4	"										
515	52 3/4	"										
516	51 3/4	10"										
517	50 3/4	"										
518	52 3/4	"										
519	51 3/4	14 1/2"										
520	50 3/4	"										
521	52 3/4	"										
522	51 3/4	12 1/2"										
523	50 3/4	"										
524	51 3/4	10"										
525	51 3/4	10"										
526	50 3/4	"										
527	52 3/4	"										

Serial Number	Cubic Feet of Air Per Min.	Capacity in Equivalent Square Feet Direct Steam Radiation and surplus surface for heating, at various entering air temperatures													
		+30°		+10°		0°		-10°		-15°		-20°		-30°	
		Tot. Cap.	Htg. Cap.	Tot. Cap.	Htg. Cap.	Tot. Cap.	Htg. Cap.	Tot. Cap.	Htg. Cap.	Tot. Cap.	Htg. Cap.	Tot. Cap.	Htg. Cap.	Tot. Cap.	Htg. Cap.
501	1200	267	111	295	62	310	38	324	13	332	1				
504	1200	301	137	334	100	350	78	366	55	375	44	383	33	399	10
502	1200	308	153	341	107	358	86	374	63	383	52	396	41	407	19
507	1200	333	177	359	135	387	115	406	94	415	84	424	73	441	52
505	1200	345	189	382	148	401	128	419	108	429	98	438	86	457	67
503	1200	355	200	394	160	413	137	432	121	443	112	452	102	471	82
508	1200	380	224	420	187	441	168	462	137	472	137	482	132	503	113
506	1200	396	241	438	205	460	188	482	170	493	162	503	137	525	135
509	1200	433	277	478	245	503	230	526	215	538	207	550	199	573	184
510	1350	291	116	322	60	338	32	354	4						
513	1350	329	154	365	102	383	76	400	50	409	37	419	25	437	0
511	1350	336	161	372	109	390	84	408	58	417	46	427	32	455	7
516	1350	365	189	405	142	425	118	444	94	454	82	465	71	484	46
514	1350	377	202	418	154	438	132	459	108	470	97	480	85	500	62
512	1350	388	213	430	167	451	145	472	122	482	110	493	99	514	76
517	1350	416	240	461	197	483	154	505	154	517	144	528	135	550	113
515	1350	433	258	479	216	503	197	526	176	538	154	551	154	573	136
518	1350	475	300	525	262	552	245	577	227	590	218	603	209	628	154
519	1500	314	120	348	56	366	25								
522	1500	356	161	394	102	413	72	432	43	442	28	451	14		
520	1500	362	167	400	109	421	80	440	51	450	36	460	22		
525	1500	394	171	437	145	458	118	479	90	490	76	501	63	522	35
523	1500	407	213	452	160	474	134	497	107	507	94	519	81	541	54
521	1500	418	224	464	171	487	146	509	120	520	107	532	94	555	69
526	1500	450	255	498	206	523	171	547	158	559	146	572	134	596	110
524	1500	468	274	518	226	543	203	568	171	581	168	594	157	620	134
527	1500	513	318	567	276	596	256	623	234	638	171	652	171	678	171

PORTABLE UNIT VENTILATORS—Univent (Continued). No. 6-H

Copies of this Data Sheet, printed separately, 5 cents each.

THE HEATING AND VENTILATING MAGAZINE—1123 BROADWAY, N. Y. CITY

VAPOR HEATING.

The Dual System.

The dual system derives its name from the fact that a typical installation, as shown in Fig. 1, may be operated as a vapor system or with pressure. The term vapor, as used by the manufacturers of this system, refers to atmospheric pressure, or within an ounce or two of atmosphere, while the term pressure refers to above 1 lb. gauge. An additional factor relative to the name of the system, is the use of a Dual valve on each unit of radiation, and at drip points.

The manufacturers do not advocate dripping the supply main to the return through traps or otherwise if possible to avoid such an arrangement. All Dual systems are designed to permit the supply main to be carried back to the boiler, and venting is provided for at that point.

When operated as a vapor or atmospheric system, the Dual boiler return trap (Fig. 4) does not function except to co-operate with the Dual air eliminator (Fig. 5) to permit the exit of air from the system. Under this condition, the condensation returns to the boiler by gravity. If the pressure is created on the system the Dual boiler return trap is forced to function automatically by the returning condensation.

One of the primary factors assisting in the operation of the Dual system is the use of the Dual air eliminator on the end of the return main, ahead or in front of the Dual boiler return trap. This eliminator is designed to permit the unrestricted elimination of air, when operating near atmospheric pressures, and, when operating under pressure, to relieve to a large extent the duty of the boiler return trap in eliminating air from the system. The outlets of vents on drip mains are connected to the air eliminator so as to prevent air from being drawn back into the system.

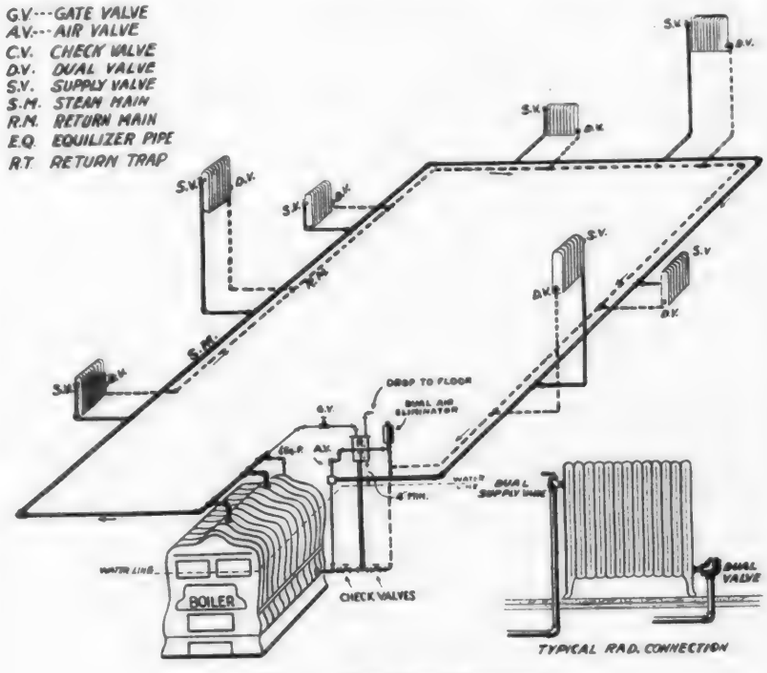


Fig. 1. The Dual System.

(Continued on Data Sheet No. 132-SS)

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THE HEATING AND VENTILATING MAGAZINE—1123 BROADWAY, N. Y. CITY

VAPOR HEATING.

The Dual System.

(*Continued from Data Sheet No. 132-RR*)

In addition, a metal diaphragm damper regulator is provided to give positive and sensitive control of the boiler pressure.

The general system of piping employed with a Dual system does not differ radically from other vapor systems, with the exceptions noted. The Dual valve, it will be noticed, is installed on the return end or the outlet, and the Dual graduated supply valve on the inlet of each radiator of the system.

As will be seen from Fig. 2, the operation of the Dual valve is almost self-explanatory. When installed the float is down in which position it holds in place the valve at the outlet opening. A hollow valve stem is used for the elimination of air, care also being taken to provide an area as large as the inlet of the ordinary thermostatic trap.

It is not necessary for condensation to collect in the trap body and raise the outlet valve to permit the air to make its exit. When all air has passed through the hollow valve stem, the steam or vapor naturally follows. When this steam or vapor comes in contact with the bi-metallic strip at the top of the valve stem, it acts to prevent the passage of the steam or vapor to the return line. The Dual valve now operates purely as a float valve and is governed only by condensation and not temperature.

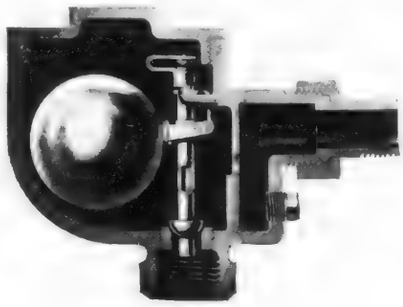

Fig. 2—The Dual Valve.

CAPACITIES AND SIZES OF DUAL VALVE

Size, In. Diam.	Capacity Sq. ft. Direct Radiation.	Center Outlet to End of Spud, In.	Center Spud to Face of Outlet, In.	Pipe Connection In. Diam.
½	200	3 ¼	2 ½	½
¾	500	3 ½	2 ¾	¾
1	1400	4	3 ¼	1

As the steam or vapor condenses in the radiator or other vessel, it flows into the Dual valve, causing the float to rise and permitting the condensation to flow to the return pipe. As condensation continues to form, the Dual valve operates as a continuous float trap with water seal. In this way the air and condensation are eliminated simultaneously. When steam or water is shut off from the radiator or other vessel, the Dual Valve acts to permit all water to make its exit and again the float drops to the bottom of the valve, closing the seat at the outlet. The importance of this feature will be apparent where there is likelihood of freeze-ups. The point is also made that the bi-metallic strip and hollow valve stem constitute a trap by themselves, in the event that the float mechanism should cease to function. It is to be noted that the Dual valve is made without the use of solder, diaphragm or volatile liquid.

The Dual boiler return trap is designed to perform all the functions of any reliable direct boiler return trap in relieving all air from the heating system and in returning the water of condensation to the boiler, regardless of pressures up to 20 lbs. The vacuum which it creates in this process is depended upon to aid the rapid circulation of steam or vapor throughout the system. The water of condensation flows by gravity into the trap, lifting a float which serves to automatically close the air relief valve and to open the steam valve, admitting boiler pressure to the top of the trap. The pressure in the boiler and in the trap being thus equalized, the water in the trap passes into the

(*Concluded on Data Sheet No. 132-TT*)

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THE HEATING AND VENTILATING MAGAZINE—1123 BROADWAY, N. Y. CITY

VAPOR HEATING.

The Dual System.

(Concluded from Data Sheet No. 132-SS)

boiler and the receding float then closes the steam port. At this point the steam contained in the trap condenses and creates a vacuum which hastens the return of more air and water. After all the air has been expelled, the Dual boiler return trap is depended upon to maintain a vacuum on the return lines.

The Dual system is manufactured by the Heating & Power Appliance Company, of Milwaukee, Wis., and is described as the result of many years of effort on the part of the company's engineering department.

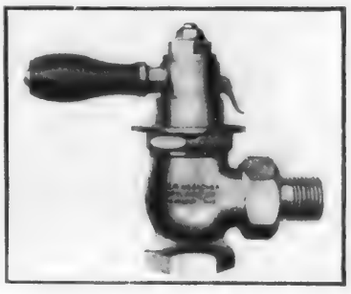


Fig. 3. Dual Graduated Supply Valve.

CAPACITIES AND SIZES OF THE DUAL GRADUATED SUPPLY VALVE

Size, In. Diam.	Capacity Sq. ft. Direct Radiation.	Center Outlet to End of Spud, In.	Center Spud to Face of Outlet, In.	Connection Pipe In. Diam.
½	30	2 ¼	1 3-16	½
¾	100	2 ½	1 3-16	¾
1	200	3	1 ½	1

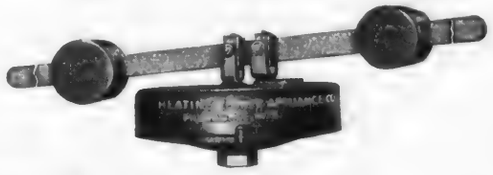


Fig. 4 (at left) Dual Boiler Return Trap.

Fig. 5 (at right) Dual Air Eliminator.

Fig. 6 (above) Dual Damper Regulator.

Copies of this Data Sheet, printed separately, 5 cents each.

TRADE MARK REG.

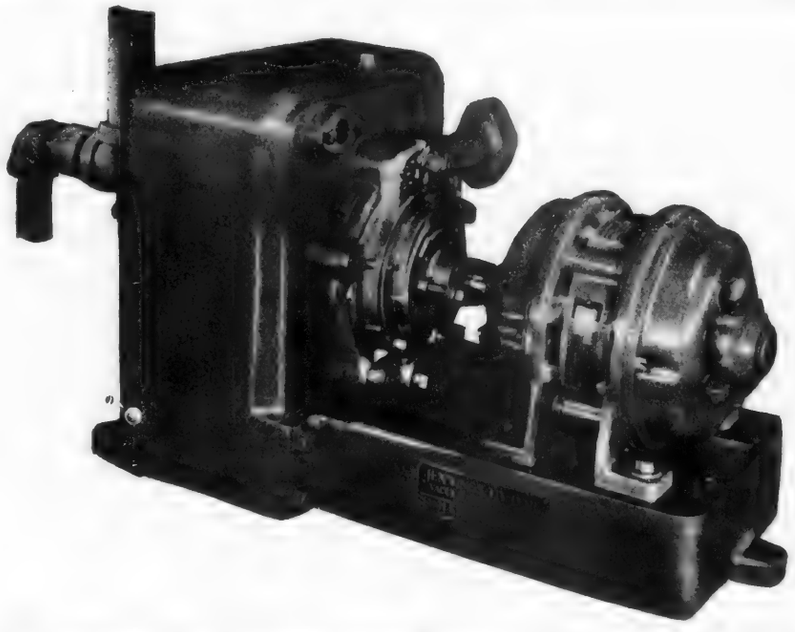
Typical
Jennings
INSTALLATIONS
A Series
INDIANAPOLIS

National City Bank Building
Fletcher American Bank Building
Reserve Loan Life Insurance Company
Palace Theatre
J. F. Wild Bank
Duckwall Realty Company — 2 pumps
H. C. Stutz Motor Company
Guarantee Building
Murat Temple
Indiana Central College
Lincoln Hotel
Severin Hotel
S. M. Bixbe Company
Allison Experimental Company
Central Avenue M. E. Church
City Hall, Indianapolis
Adams Rogers Company
Walter A. Ristow Greenhouse
St. Peter & Paul School
Highland Golf Club
Plaza Garage
Millikan Apartments
Dollman Apartments
Lumley Apartments
Climax Machinery
Parcel Post Bldg.
Brennecke Building
Thompson Restaurant
Central States Envelope Company

The Jennings Hytor

Return Line Vacuum Heating Pump

Heart of the Heating System



Size "M" Jennings Hytor Vacuum Heating Pump with integral tank. This pump has ample capacity for 5,000 square feet of equivalent direct radiation, requiring only ¾ horse power motor at 1800 R. P. M. when delivering from a vacuum of 10" of mercury against 10 pounds gauge pressure at the pump.

No matter how well designed a Return Line Heating system may be, its satisfactory operation is largely dependent upon the proper functioning of the Vacuum Return Line Pump. The Jennings pump has proven on thousands of installations that it possesses the features necessary for proper operation under the most extreme conditions.

Jennings Return Line pumps are simple in construction, containing but one moving element, running with a clearance in the casing. They are simple to install and operate, they require little floor space and are noiseless in operation. Their use results in a marked economy in coal. Many users hold that they more than pay for themselves in this respect alone. A Jennings pump on your system means quick heat in the most isolated radiators at a minimum steam pressure.

Now is the time to consider equipment for replacements and new installations for next season. Our Engineering Department is at all times ready to render service on problems relating to heating.

NASH ENGINEERING CO.
SO. NORWALK, CONN., U. S. A.

Trade and Miscellaneous Notes

Miscellaneous Notes.

Evanston, Ill.—The Evanston Board of Education has purchased a separate tract of ground on which it will build a power plant to heat the high school. Heat will be conveyed to the high school through an underground passage. The board decided to erect the power plant separate so as not to mar the beauty of the high school building. Another feature also was the fact that the power plant could be located adjacent to railroad tracks, thus providing economical handling of coal.

New York—The New Vehicular Tunnel under the Hudson River, connecting New York and northern New Jersey, will be equipped with special electrically-driven ventilating apparatus, consisting of blower fans which will pump 3,600,000 cu. ft. of fresh air per minute. Air will be discharged from the tunnel continuously, limiting the amount of carbon monoxide to four parts in 10,000, no mater how dense the traffic. The tunnel will have a capacity of 3,800 vehicles an hour.

Los Angeles, Calif.—Announcement has been made that Professor Guido Blenio is to locate in Los Angeles for the purpose of continuing his studies of light and heat. Among other things he expects to work on his discovery of a radio-active light in liquid form which he claims will burn for many years. Eventually he predicts his discovery will make coal and fuel oils, or any other present source of power, things of the past.

Oakland, Cal.—The ventilation of the tunnel to be constructed between Oakland and Alameda, Calif., presents a simple problem, according to Harry E. Squire, engineer of the California State Board of Harbor Commissioners. "A ventilation shaft will be located on each side of the channel, with sets of powerful fans to pump out bad air and bring in the good," he said. "There will be no danger, whatever, in using this tube."

Central Heating Apparatus used in a Roman villa about 17 centuries ago has been uncarthed at Kenysham cemetery, Somersetshire, England. The villa, which was about 120 ft. long, was heated by a hypocaust or heating chamber, the heat passing under the floors of various rooms by means of a sense of passages. Some rooms were reached by means of flues.

Bay City, Mich.—A modern heating plant is to be erected by the Chevrolet Motor Co., at its Bay City plant. In order to permit the construction of the heating plant the city commissioners have ordered the permanent closing of Annie Street near the site of the plant.

Central Supply Association held its 29th annual meeting at the Drake Hotel, Chicago, October 3 and 4, 1923. An interesting program was carried out, including an address by H. E. Byram, president of the Chicago, Milwaukee & St. Paul R. R. company. Other features of the meeting were an address by former Congressman J. Adam Bede, who recently returned from abroad, and a brief talk on the apprenticeship situation by William J. Woolley, manager of the National Trade Extension Bureau.

Building Construction, which began to decline in June, continued to decline slightly through August, according to reports to the F. W. Dodge Corporation. The August drop from July, however, was small, only 5%. August

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1. **Motor will operate indefinitely under full load at the correct temperature for highest fan efficiency.**
2. **Protected motor prevents air containing grease, acids, moisture, grit or other foreign substances from contaminating motor windings.**
3. **Elimination of costly break downs and burn outs, which in many instances are caused by contamination of motor windings.**
4. **Motor windings, after years of service, are as clean as when originally installed.**
5. **Operating expense is reduced to lowest minimum cost.**
6. **Complete fans are systematically designed, compact, neat appearing, with no awkward, cumbersome or superfluous parts.**
7. **Guaranteed assurance as to customer's future satisfaction.**
8. **Guarantee of fan and motor by one company.**
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10. **Quietness of operation, neatness in appearance and ease of installation.**

Autovent Fan & Blower Co.

"Dept. H"

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building construction in 36 eastern states, including about seven-eighths of the total construction volume of the country, amounted to $298,629,000. Contracts awarded in New York State and northern New Jersey totaled $81,747,000 or only about 2% below July and 1% above the corresponding month last year.

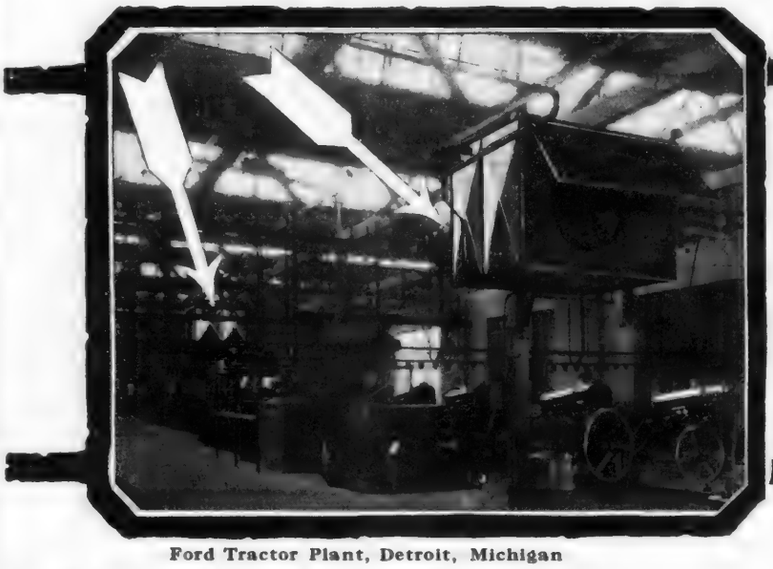
American Gas Association expects 3,000 executives of manufactured gas companies to attend the association's annual convention at Atlantic City, N. J., October 15-19, 1923, when plans will be devised to take care of the future cooking and heating requirements of approximately 400,000 new customers who have been added to service mains this year. The record this year exceeds all previous ones and has called for the financing of a $450,000,000 building and expansion program. The sale of gas ranges, water heaters, room heaters and other appliances amounted, this year, to $45,000,000, a record figure, the association announces.

Chicago, Ill.—Members of the heating industry in Chicago held their annual "heating trades" outing at Sylvan Beach Hotel, Channel Lake, Antioch, Ill., September 7, 8 and 9, last. The committee which had charge of the affair and were largely responsible for its success included: Charles Glennon, Thomas I. Magan, George A. Hendrich, J. W. Storey, Fred Dilzer, C. E. Barrows, Charles G. Lamb, George Lavelle, James Doherty, and Arthur B. Martin.

International Standardization in industry was discussed at a meeting of secretaries of national industrial standardization bodies, representing thirteen countries, during the summer at Zurich and Baden. Substantial progress on overcoming the many difficulties presented was made, particularly in planning greater facility in interchange of information between the various national bodies during the development of the work in the different countries. Provision was made for continuing the work of the international conference on the many administrative problems of common interest through a loose-knit continuing organization.

"How to Own Your Own Home" is the title of a guide book, designed for the prospective small home owner and

—To The Man Who is Interested In More Heat for Less Money ···



Ford Tractor Plant, Detroit, Michigan

When a mammoth organization like the Ford Tractor Plant makes three installations of ILGAIR Unit Heaters totaling 54 units, it represents an endorsement of one of this country's foremost Industrial plant engineers.

A Valuable Book *for* Architects and Heating Engineers

Showing How to Keep the Heat Circulating at the Floor Level

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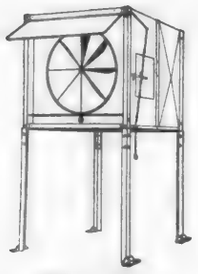

Floor Type
Note Ceiling Type in Picture

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Carrier Air Washer

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Improved attendance and production records as well as the profit sheet record the results.

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CARRIER AIR CONDITIONING CO. of America

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published by the United States Department of Commerce. The book may be obtained from the Superintendent of Documents, Government Printing office, Washington, D. C., for 5 cents. It carries a foreword by Secretary of Commerce Herbert Hoover. An interesting feature of the book is an explanation of what ratio of income may be safely devoted to the process of acquiring a home. Tables dealing with the ratio of income to home investment are presented.

U. S. Department of Commerce, Washington, D. C., has issued a revised and enlarged edition of "Commercial and Industrial Organizations in the United States" containing a list of more than 11,000 organizations. This is the fifth edition of this popular directory and may be obtained from the Superintendent of Documents, Government Printing office, Washington, D. C., for 20 cents, prepaid.

New York Building Congress presented the program of its Apprenticeship Committee, at a recent luncheon meeting at Hotel Plaza, New York, attended by representatives of organized labor, of building industry and of the public. The committee reported adherence of a number of unions to its program. One of the speakers warned that the influx of skilled labor from Europe is negligible and that New York, as well as the country at large, must look to adequate training of apprentices for its future labor.

Carnegie Institute of Technology, Pittsburgh, Pa., has added eight courses in heating, ventilating, blowers and exhaust pipe work, architectural sheet-metal work, skylight work and sheet-metal pattern drawing. The new courses are separate from the regular four-year sheet-metal courses for apprentices. The work will be covered in one year of evening study extending from Oct. 1 to May 2.

National Association of Brass Manufacturers held its annual meeting at the Old Colony Club in Hotel Cleveland, Cleveland, O., Sept. 13.

Campbell-Ewald Company, Inc., New York, advertising agents, announces the appointment of F. M. Cockerell, formerly promotion manager of the McGraw-Hill Company, as manager of industrial advertising with headquarters at the company's New York office, 18 West 34th Street.

Standardization of Products used in the gas industry, suggested in a survey by the American Gas Association in cooperation with the American Engineering Standards Committee, includes reduction in the number of styles, sizes, grades or catalog lists of gas stoves and ranges, water heaters, valves and fittings, power plant supplies, and solid fuel and gas-fired boilers and furnaces.

Research University, Washington, D. C., has adopted the co-operative educational plan, whereby students will alternate six weeks in college and in industry. The plan, as announced by the University, will follow closely that first put into effect at the Engineering School of the University of Cincinnati, and involves close co-operation between the university and business. Students are carefully selected in pairs, and each pair is found a job in industry along the line of the students' best development.

Chamber of Commerce of the United States has issued an analysis of foreign trade showing that while cotton remains secure as the country's most important export commodity, coal and coke have advanced to second place, moving up from fourteenth position. This is the highest place coal and coke ever has had. Automobiles and their parts have advanced to third place.

Allegheny County Steam Heating Co., Pittsburgh, Pa., a subsidiary of the Philadelphia Company, is building a new plant to supply heat and power in the Point district of Pittsburgh, Pa. The expected demand from the district may reach ultimately 30,000 boiler horse-power and in order to meet this condition Dwight P. Robinson & Co., engineers and constructors, New York,

PUBLIC SCHOOL No. 62, BRONX, New York City, N. Y.
Over one Hundred Lehigh Fans are installed in New York City Schools
Engineers—New York Board of Education.
Contractors—Federal Heating Co., New York City

LEHIGH MULTIBLADE FANS

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WHERE large volumes of air are to be handled at comparatively low pressures such as in heating and ventilating systems LEHIGH Multiblade Fans are guaranteed to be equal to, if not superior, to any other fans on the market.

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The proper distribution of fresh air is of great importance in business buildings. It imposes no financial burden because the value of work done in well-ventilated rooms guarantees a return greatly in excess of the investment. This principle was recognized by the Union National Bank of Boston in its new building where the banking rooms and vaults are scientifically ventilated with

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The long list of important buildings with Sturtevant equipment is our especial pride. It illustrates the confidence that owners and architects in every city of the country have in our products and service and includes buildings of every type. Such long and varied experience insures competent advice and we invite architects to consult us on their heating and ventilating problems. In each of our offices listed below a qualified engineer is ready to serve you.

The Union National Bank Building, Boston, Mass.
Blackall, Clapp & Whittemore — Buerkel & Company
Lewis H. Bacon — Architects — Engineers

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Sales Engineering Offices:
Atlanta, Ga.
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Cleveland, Ohio
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Hartford, Conn.
Indianapolis, Ind.
Los Angeles, Cal.
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Divisional Factories
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Sturtevant
PUTS AIR TO WORK

Sales Engineering Offices
New York, N. Y.
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St. Louis, Mo.
Salt Lake City, Utah
San Francisco, Cal.
Seattle, Wash.
Springfield, Mass.
Washington, D. C.

have designed a boiler plant to be finally equipped with four boilers, each having 29,884 sq. ft. of heating surface, fired with pulverized fuel and capable of generating 9,000 boiler horse-power continuously. The new plant is described in detail in the September issue of *The News,* published by this engineering firm.

National Trade Extention Bureau will hold the annual conference of its advertising and sales managers and supporting members at the bureau's headquarters in Evansville, Ind., October 29-31. At this conference the program of monthly sales campaigns for the heating and plumbing industries for 1924 will be prepared. Headquarters will be at the Hotel McCurdy.

United States Civil Service Commission announces that an open competitive examination for architectural draftsmen will be held throughout the country on November 7 and 8, to fill vacancies in the departmental service. Entrance salaries are from $1,500 to $2,000 a year, plus the increase of $20.00 a month granted by Congress.

J. E. Bolling, of the Carrier Engineering Corporation, Newark, N. J., who spent several weeks in Europe during July and August, inspected a number of the company's installations in London, notably those in the London County Council Building and in the English studios of the Famous Players-Lasky Company. He also visited the automobile plant of Citroen in France.

F. W. Herendeen has resigned as chairman of the American Society of Heating and Ventilating Engineers' Sub-Committee 7 (Heating Boiler Capacity) of the Committee on Code of Heating and Ventilating. He has been succeeded by J. F. McIntire, of Detroit, chief engineer of the United States Radiator Corporation.

Charles F. Haynes, vice-president and general sales manager of the Hoffman Specialty Co., Waterbury, Conn., during his recent trip abroad, met, among others, President Watson of the (British) Institution of Heating and Ventilating Engineers, to whom he carried the greetings of President H. P. Gant, of the American society; also W. Nelson Haden, who entertained Mr. Haynes. In Paris Mr. Haynes met Henry S. Downe, an old figure in the heating trade and also L. H. Prentice of Chicago, who was on a continental tour. Mr. Haynes made the trip from London to Paris by airplane.

American Steel Concrete Buildings in Tokio and Yokohama withstood the earthquake shock and are in good condition, according to a cable from Assistant Trade Commissioner G. C. Howard at Kobe.

American Construction Council announces the creation of additional executive positions to expedite the administration of the expanding activities of the council. D. Knickerbacker Boyd, president of the Philadelphia Building Congress, has been named executive vice-president of the council and Dwight L. Hoopingarner, formerly executive manager of the Cleveland Building Trades Employers' Association, has been appointed the council's executive secretary. The efforts of the council are being directed first on several of the most urgent problems confronting the construction industry, such as promotion of and co-operation with local building congresses, a national survey of apprenticeship needs and conditions of labor supply, promotion of the stability of employment and reduction of unemployment, comprehensive steps toward the determination of the causes and the elimination of waste in all its phases throughout the industry, a general educational program as to the problems of the industry and its development, and the promotion of the concept of construction activities as a great American industry.

The council recently moved into new quarters in the National Association Building, 28 West 44th Street, New York.

Manufacturers' Notes

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been awarded the contract to furnish the electrical equipment to be used for ventilating the new Liberty tunnel under Mt. Washington, Pittsburgh, Pa., for $90,000. The contract covers lighting apparatus as well. Ventilating equipment required includes two 200 kw. synchronous converters, transformers, two 300 kw. synchronous converters, eight 40 H. P. direct-current motors to drive fans, eight 85 H. P. motors, and direct-current drive fans.

Sarco Co., Inc., New York, has appointed R. C. Doerr, formerly sales representative for the National Meter Co., as the Sarco engineering sales representative in northern New Jersey.

American Schaffer & Budenberg Corporation, Brooklyn, N. Y., is the new name chosen for the merged Schaeffer & Budenberg Mfg. Co., and the American Steam Gauge & Valve Mfg. Co., thus retaining a name indicative of both concerns. Announcement is made, coincident with selection of the new name, that the company's engineering and sales departments have been improved greatly during the year since the two firms consolidated and its line of valves and instruments for indicating, regulating and controlling of pressures, temperatures and speeds greatly extended.

American Radiator Co., Buffalo, N. Y., has completed its absorption of the Dominion Radiator Co., Toronto, Can., and the Dominion Radiator & Boiler Co., New York, has been formed as a subsidiary of the American Radiator Company to operate the old Dominion company in Canada and to manage the American Radiator Company's own branch in Brantford, Ont. Stock of the new subsidiary has been listed on the Toronto Stock Exchange.

McNab & Harlin Mfg. Co., Patterson, N. J., which has been in the hands of receivers for several months, has been granted a 60-day extension by creditors to give the company a further opportunity to continue operations. S. D. Leidesdorf & Co., New York, are the receivers.

United States Radiator Corp., Detroit, Mich., announces the company's Minneapolis, Minn., branch will move January 1, 1924, from 901 South Washington Ave., Minneapolis to the Midway district, St. Paul, Minn.

American Radiator Co., Buffalo, N. Y. has purchased for $755,000 the Elmwood Avenue plant of the Curtiss Aeroplane Co., Buffalo. The property consists of 79 acres of land and buildings totaling 1,300,000 sq. feet. A subsidiary company to be known as the American Terminal Warehouse Corporation will be formed to handle the property, a part of which is to be leased to outside manufacturing interests. The American Radiator Company will use some of the space for the manufacture of heating equipment.

Walworth Manufacturing Co., Boston, Mass., held its annual summer outing for executives and employees recently at Rainsford Island in Boston Harbor. Two specially chartered boats handled the 2,000 picnickers, the party including President Howard Coonley, who is also president of the Boston Chamber of Commerce.

Sarco Co., Inc., New York, it is announced, is now controlled by Clement Wells, who has become president of the company. G. H. B. Burke, western sales manager, has been named vice-president, and E. J. Ritchie is a new member of the board of directors.

Hoffman Specialty Co., Waterbury, Conn., has appointed George W. Barr assistant general sales manager, with headquarters in Philadelphia. W. R. Mead has been appointed manager of the company's Toledo branch, succeeding Frank C. Reeder, who, as already announced, is back with the Fulton Company.

Power Specialty Co., 111 Broadway, New York, has appointed John Blizard to the position of research engineer for the company. He will specialize at present on heat transmision problems. Mr. Blizard is perhaps best known to heating engineers for his work at the U. S. Bureau of Mines. Previous to that he was for a number of years fuel engineer for the Canadian government, and later a lecturer in mechanical engineering at McGill University, Montreal.

Warren Webster & Co., Camden,

IVANHOE MASONIC TEMPLE

KANSAS CITY, MO.

SMITH, REA & LOVITT, *Architects*
Kansas City, Mo.

MAGILL PLUMBING & HEATING CO., *Contractors*
Kansas City, Mo.

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CHICAGO, ILLINOIS

Factory: LaPorte, Indiana. **Branch offices in principal cities.**

Our engineers are prepared to give expert advice on cooling, evaporating and conveying systems

WRITE FOR CATALOGS

N. J., announces the opening of an office in Des Moines, Ia., at 708 West 34th Street. This office will be operated as a branch of the company's Chicago office and will be in charge of Hugo R. Sindelar, who has been connected with the Chicago office for a number of years.

Central Station Heating Notes

Bloomington, Ill.—The last of the steam heating mains required in an order of the Illinois Commerce Commission, which authorized the abandonment of its water heating mains, has been laid by the B. & N. Railway & Light Co. The company is "now up to capacity" and is supplying all the buildings it can care for, according to the superintendent.

Tacoma, Wash.—An ordinance has been presented calling for the appropriation of $58,000 to be used in installing burners under boilers at the Dock Street plant to give the city a complete steam generating plant. It was indicated that favorable action on the ordinance might mean cancellation of the city's contract with the Consumers' Central Heating Company.

Blue Earth, Minn.—Voters have authorized a bond issue of $75,000 to extend the municipal heating system to city schools and churches.

Decatur, Ill.—It cost each of the nine customers of the community heating plant in West North Street an average of $1.28 a day for 103 days of heating service given them last winter, according to a report recently issued. The success of the venture is assured, it is stated, and additional customers to be added this winter are expected to reduce the cost from 25% to 33⅓%. The original members of the community project paid an entrance fee of $1,000 each and this fee has been increased to $1,500 for all who join in the future.

New Hampton, Ia.—The city of New Hampton has advertised for bids for the construction of a central heating plant. Arrangements have been made to furnish heat to several business houses and one residence. A 200 H. P. boiler will be installed for use in conjunction with two 150 H. P. boilers already installed. The smokestack at the power plant has been increased to a height of 125 ft.

New Incorporations

Crosby & Beard Co., 163 West Harrison St., Chicago, capital $10,000 to operate a heating and steamfitting business. Incorporators: Burton H. Crosby, John Beard, and Herschell M. Byall. Correspondent, Alden, Latham & Young, 134 S. LaSalle St., Chicago.

Colombo Plumbing & Heating Co., Inc., 416 E. Broadway, Johnson City, Ill., Capital $10,000 to conduct a heating and plumbing business. Incorporators: R. C. Cluster, Ceasare Colombo and John B. Gustat. Correspondent, Charles Cazaleen, Illinois Bldg. Johnson City.

Yelton Weaver Supply Co., 818 E. Adams St., Springfield, Ill., capital $55,000, to manufacture and deal in heating, plumbing, factory and mining devices and materials. Incorporators: H. C. Yelton, Fred McMachan and William W. Yelton. Correspondent, Acton, Acton & Snyder, The Temple Bldg., Danville, Ill.

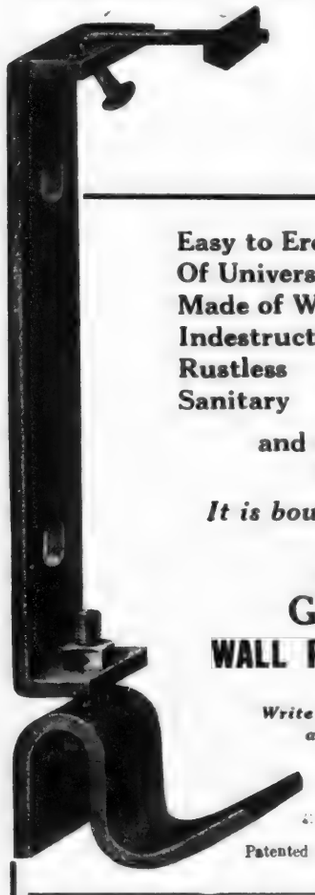
Builders Plumbing & Heating Co., Indianapolis, Ind., capital $5,000 to install heating and plumbing apparatus. Directors: Lyle T. Laub, Fritz G. Heinrich and Peter Wandell.

Stark Heating Co., Denver, Colo., capital $25,000. Incorporators: S. R. Jones, Adrienne Jones, and Wallace W. Keene.

Domestic Engineering Co., Columbus, O., capital $10,000, to conduct a heating and plumbing business. Incorporators: Harry E. Richter, George T. Shears, Walter H. Richter, Louis F. Thiel and William W. Fletcher.

Contracts Awarded

Christopher & Farquharson, Belling-



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Indestructible
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and will fit any make wall radiator

It is bound to be Economical and Ideal

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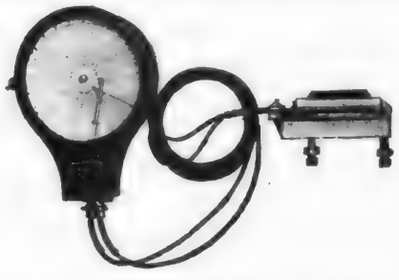
WALL RADIATOR BRACKET

Write for Descriptive Booklet and Trade Discounts

Prompt Shipments

Patented **A. F. GLEOCKLE, Jr.**
415 Bay St., Rochester, N. Y.

Specifying "Gleockle" Brackets is one way of saving your client money



RELATIVE HUMIDITY

Perhaps you may have the very best humidifying equipment. But, how do you know it is always functioning correctly unless you have some means of checking the accuracy? The answer is--

TRADE MARK
BRISTOL'S
REG. U.S. PAT. OFFICE

Recording Wet and Dry Bulb Thermometer

With this equipment you can know the relative humidity for any hour of the day or night. The initial expense is not big and the maintenance almost nothing.

Bulletin N-311 devoted exclusively to Bristol's Humidity Recorders. Shall we send you a copy?

THE BRISTOL COMPANY
WATERBURY, CONN.

Boston New York Philadelphia Pittsburgh Detroit Chicago St. Louis San Francisco

Airplane view by The Fairchild Aerial Camera Corp. Cornell University, Ithaca, N. Y. Buildings connected by Johns-Manville underground system of insulation. Note Power house shown at upper center.

At Cornell

—a two mile installation of the Johns-Manville system

Over two miles of the Johns-Manville Underground System of Insulation play an important part in the new 4500 H.P. central heating plant system at Cornell University.

Steam is transmitted underground at 200 lbs. boiler pressure to reducing valves at the buildings. This permits small mains to be used, which are insulated by the Johns-Manville System with minimum first cost, especially as compared with the far greater cost of walking tunnels. This method is not only less expensive, but more efficient which reduces operating losses to the absolute minimum—a double economy.

The Johns-Manville System combines an efficient method of insulating pipe lines underground with an engineering service that has been highly successful in adapting this method to specific problems. Hundreds of successful installations bear witness to the exceptional economy of this system.

JOHNS-MANVILLE Inc.
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Branches in 59 Large Cities
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ROOFINGS
PACKINGS
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JOHNS-MANVILLE

Underground System of Insulation

ham, Wash., heating the new county building at Mount Vernon, Wash., for $11,620.

Kinninson Bros., Dallas, Tex., heating and ventilating new high school and three ward schools at Corsicana, Tex., for $52,853.

George Foley Co., Kansas City, Mo., heating, ventilating and plumbing new Junior and Senior high school building at Warrensburg, Mo., for $32,845.

Spokane, Wash.—Bids were received as follows for heating, ventilating and plumbing the new addition to the Masonic Temple: Arnold-Evans, Spokane, $52,000; James Smyth Co., Spokane, $51,300; H. B. DeLong, Spokane, $53,747; and I. J. Blair, Spokane, $51,985.

Edwardsville, Ill.—Bids were received as follows for heating the new high school building: Elliott & Barry, $26,215; M. Desmond Mfg. Co., $26,848; Edwards Heating Co., $26,640, Capitol boilers $260 extra; and Alton Heating & Plumbing Co., $29,370. The lowest bids for general contract, heating and plumbing totaled considerably above the architect's estimate.

McCarthy & Johnson Heating & Engineering Co., Denver, Colo., heating addition to the Columbian school, Denver, for $22,296.

Monitor Boiler Co., Philadelphia, Pa., to manufacture and sell steel water-tube boilers of the coil type. Officers include: D. W. Ritchey, Philadelphia, president; Robert W. Groezinger, Lancaster, Pa., vice-president; C. S. Reed, Lancaster, treasurer; and W. E. Forrer, Philadelphia, sales manager.

Kendall Heating Co., Portland, Ore., heating and ventilating new Washington high school for $33,436.

Council Bluffs, Ia.—Bids were received as follows for heating the new Bennett building: J. C. Bixby, $12,970; New York Plumbing Co., $14,300; Joe Hansen, $14,440; Robert Parks, $14,900; Stephan Bros., $14,996; and J. M. Buggy, $15,285.

E. J. Fogarty, Harrisburg, Pa., heating and ventilating new high school shops for $17,000.

Denton, Tex.—M. B. Whitelock, Denton, constructing concrete steam tunnels for C. I. A. central heating plant, for $47,517.45; Tennison Bros., Dallas, are installing the mechanical equipment, for $46,526.

Alaska Plumbing & Heating Co., Salem, Ore., for installation boilers and plumbing in new heating plant at the State Institution for Feeble Minded at Salem, Ore., for $38,640.

Custer, S. D.—All bids for the construction of a new heating plant at the State Sanitarium for Tuberculosis here were rejected because they exceeded the appropriation of $50,000.

Phelps-Underwood & Co., Lincoln, Neb., heating and plumbing new high school building at Fairbury, Neb., for $39,000.

A. Holtman Heating Co., Kansas City, Mo., for heating new high school at Liberty, Mo., for $34,496.

Mathey Plumbing Co., Le Mars, Ia., was low bidder for heating, ventilating and plumbing for new school building at Le Mars, with bid of $24,746, subject to deductions and additions for alterations.

Justus & Schenck, Kansas City, Kan., for heating the new Soldiers and Sailors memorial, Kansas City, Kan., for $32,890.

Pacific Gas Appliance Co., San Bernardino, Calif., for heating and ventilating new high school at Montebello, Calif., for $20,000.

Jacksonville, Fla.—Bids were received as follows for heating University of Florida auditorium at Gainesville, Fla.: W. A. Manning & Sons, Jacksonville, Fla., $11,347; O'Pry Heating & Plumb-

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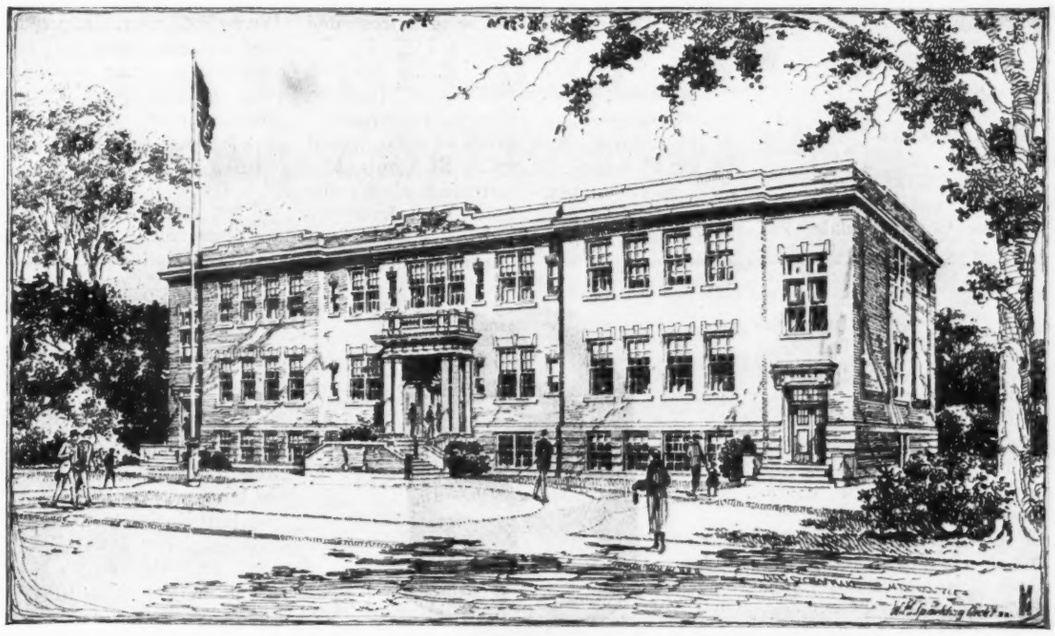

NEW EAST ROCKAWAY PUBLIC SCHOOL

William H. Spaulding, Architect, Jamaica, N. Y.
Lawrence J. Bennett, Contractor, Hempstead, N. Y.

Planned for the Future

When it becomes necessary for East Rockaway to have a larger school, additional wings will be added to this building.

With these plans in mind for the future, the unit system was selected because of its adaptability to enlargement. Additional wings may be ventilated by simply installing a Heatovent in each new room. It will not be necessary to alter the present building as with a central fan system.

For this reason the unit system is particularly suited for medium sized schools. Each room is ventilated separately and ***only*** when it is occupied.

Write our nearest branch office and our engineer will gladly co-operate with you in every way.

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503 Wabash Bldg., Pittsburgh, Pa.
1400 Broadway, New York
1018 Fourth Ave., South, Seattle, Wash.

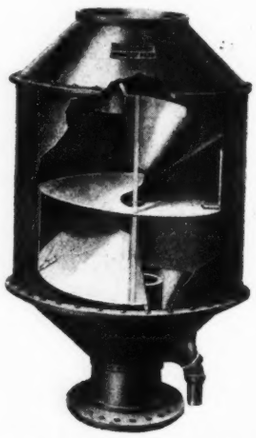
ing Co., Macon, Ga., $11,800; Loftin H. Pa. Co., Atlanta, Gas., $12,000; W. C. Burns, Jacksonville, 13,800; H. S. Bonnell, Gainesville, $13,900: Gimmle & Co., Columbia, S. C., $13,947; Walter Denson, Columbus, Ga., $15,607; and A. H. Jones Plumbing Co., Jacksonville, $15,497.

Trade Literature

THE TRUTH ABOUT OZONE is the name of a recent booklet published by the United States Ozone Co., Scottdale, Pa., containing a résumé of the work along industrial lines conducted by the engineering staff and research department of the company, together with their Industrial Fellowship at Mellon Institute Industrial Research, Pittsburgh, Pa. It is published as Technical Publication No. 14. Another recent issue of this company is known as Technical Publication No. 10, and consists of a treatise on the principles, design and action of ozone and electrolytic water-purifying apparatus manufactured by the company. Both books are illustrated with numerous drawings and figures and the latter contains also several photographic reproductions of the company's products. Size 5 x 7½. Pp. 64 and 36, respectively.

SHEPARD ELECTRIC LIFT ABOUT, a product of the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., is the subject of a well-illustrated catalogue, just issued. The booklet contains more than a score of installation pictures, depicting the Lift About moving and lifting loads in numerous industries and businesses. Data showing the saving effected by purchsers through the use of the Lift About is presented in many of the instances cited in the catalogue. Size 5¼ x 7½. Pp. 72.

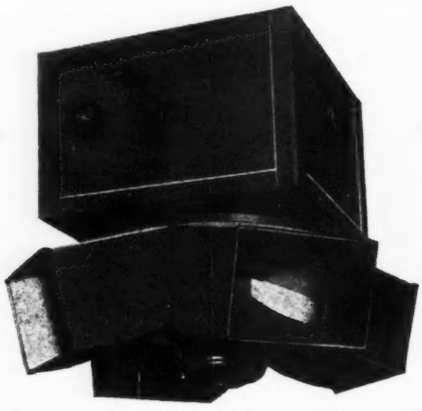
CHAMPION EXHAUST HEAD, featured as of simple and effective construction, is the subject of a recent circular issued by the Porkbeck Mfg. Co., St. Louis, Mo. The accompanying illustration shows the means taken to separate the oil from the steam and to return the condensation back to the boiler or storage tank, at the same time preventing the steam from escaping over the roof. Steam enters the main chamber of the exhaust head and is thrown against the outer wall by centrifugal force. There it condenses and drips down into the collar or return pipe. Plenty of room is provided for expansion so that there will be no back pressure on the boiler or engine. The Champion exhaust head is made of heavy-gauge galvanized steel and is furnished in 24 sizes, ranging from 1 or 1 ½-in. exhaust pipe to 36 in.



Champion Exhaust Head.

TYPE AA RELIANCE INDUCTION MOTORS are presented to the trade in Bulletin No. 5018, issued by the Reliance Electric & Engineering Co., Cleveland, O. The manufacturers point out that this type of motor, designed for two and three-phase alternating current circuits, represents the accumulated experience of the company and the recommendations and criticisms of 25 electrical engineers in the textile, automobile, wood-working, machine tool and glass plants, cement, paper and steel mills, stone yards and foundries. The bulletin is illustrated with numerous photographs and designs showing the parts and the motor installed and in operation. Size 8 x 10½. Pp. 18.

BACHARACH INDUSTRIAL INSTRUMENT Co., Pittsburgh, Pa., has issued a description of an electric CO_2 instrument, which it states, may be furnished either recording or indicating or both recording and indicating. An attachment for indicating



Install It Overhead

Install this Wing Featherweight Unit Heater overhead out of the way of machines and workers and save valuable floor space for other purposes. Attach it to the girders, roof or ceiling beams, columns or walls. Run the steam and return lines overhead.

A powerful Wing-Scruplex fan in each unit forces the heated air to constantly circulate down at a working level instead of letting it accumulate near the ceiling. The temperature at the center of the room is the same as near the walls.

Let us send you detailed information. Ask for your copy of our engineering data book.

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Unit Heaters *Small Turbines*
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Know when you have steam line leaks. Don't guess. A *Tycos* Bi-Record Recording Thermometer gives you a written record of ingoing and return steam on the same chart.

Other *Tycos* instruments for steam power plants are:

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De-Superheaters Thermometers,
Draft Gauges,
Economizer Thermometers,
Feedwater Heater,
Feedwater Line Thermometers,
Flue Gas Thermometers,
Index Thermometers,
Pyrometers,
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There's a *Tycos* or *Taylor* Temperature Instrument for every purpose

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THESE two great hotels, the management of which is noted for their buying judgment have just installed Reed all-metal air filters.

This installation insures chemically pure air for patrons, and cuts down the high cost of redecorating.

The Reed Air Filter

It is all metal—no water—no moving parts—acid, and fireproof. Lowest in first cost, and first cost is last cost.

It operates like the human nostril—nature's best filter. Air in passing impinges on the indestructible filter media coated with a simple chemical, and changes directions 11 to 18 times. Dirt, dust, bacteria, etc., are leached out and collected in a convenient unit for disposal, and cleaning.

We guarantee 97% efficiency—and Low Resistance. We sell by comparative tests. We will install on thirty days' free trial.

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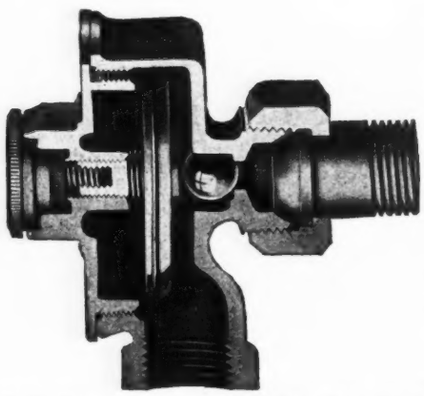
or recording CO may also be furnished with the instrument. The chart is so arranged that the CO_2 as well as the CO, may be shown on it. It is possible also to show the temperatures of flue gas. A blue-print figure, accompanying the descriptive matter, illustrates the arrangement of meter.

O-E No. 2 Thermo-Nickel Return Trap, with non-corrosive check, is brought to the attention of the trade in a new circular issued by the O-E Specialty Mfg. Co., Milwaukee, Wis. This type is of practically the same construction as the No. 1 O-E trap, with the added ball-check feature. The ball-check, made of a non-corrosive material, operates on a smooth guide or track, and is rolled to its seat against vapor or steam by the expansion of gas in the thermal member. When the radiator supply valves are closed, condensation of the steam forms a vacuum in



O-E Return Trap with Non-Corrosive Check.

the radiator which acts to hold the balls to their seats, permitting all water lines to flow freely back to the boiler, and thus eliminating the danger of broken boiler sections, at the same time preventing steam or vapor from short-circuiting into radiators through return risers. When the supply valves are opened, the vacuum is broken and the balls are thus released from their seats, permitting air and condensation to enter the return lines freely, without pressure. The ability of this trap to hold tight on a vacuum pump installation, as well as on a vapor or pressure job, and also the absence on chattering, have been demonstrated, the circular states, by exhaustive tests.

Hyperbo-Electric Flow Meters, for the measurement of steam, gas, air, water and oil, are an interesting product brought out by the Hyperbo-Electric Flow Meter Co., successors to the Sargent Meter Co., Chicago, Ill. This device was on exhibition at the recent convention of the National District Heating Association at Cedar Point, O., and was one of the products presented in the round-table discussion at that convention, the presentation being made by Julius M. Naiman, president of the company. The meter operates by securing a definite pressure in the moving fluid that has a predetermined relation to the average velocity of flow through a known area. This pressure difference is then measured and interpreted in terms of average velocity, volume, or weight, as the case may demand. The fluids to be measured are directed into definite stream lines through the use of a "hyperbolic elbow" and straightening grids, before any metering is attempted. The second distinction is that the amount of pressure difference and other variable elements are determined by a method of measuring resistance, which is declared to be unequalled for accuracy and reliability. The third notable feature is the arrangement by which the meter automatically corrects for any number of variations in factors affecting the measurement of the flow of any fluid. The Hyperbo-Electric flow meter reads directly in cubic feet per hour, pounds per hour, boiler horse-power or in any other chosen units, the proper scale being supplied for each individual meter. The recording mechanism carries an indicating scale, a graphic recorder and integrating dials.

In the measurement of steam, corrections are automatically made by the meter itself for variations in pressure of wet or saturated steam, and for temperature, as well as pressure, of superheated steam, by making use of the multiplying and dividing properties of a logarithmic Wheatstone bridge electrical circuit. The meter can be located at any distance from the metering point and can be operated from any source of electric power. Installation is made by replacing any standard or extra-heavy elbow by the 90-degree "hyberbolic elbow." Its flow coefficients are independent of local piping conditions and are constant for all loads. In addition to the "hyperbolic elbow" the main elements of the meter are the meter body, the electrical recording mechanism and the automatic correcting devices.

WANTED

Advertisements under this heading, $2.00 per inch, payable in advance. A 1-in. advertisement contains 35 words. To secure insertion copy must be received not later than the 20th of the month preceding date of issue.

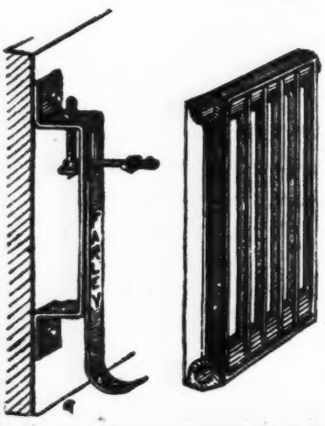
WANTED—Estimator and engineer, experienced in heating, ventilating and power work. Oil-burning experience desirable. Location New York City. State age, education, experience and salary. Address Box 101 care Heating and Ventilating Magazine.

WANTED—ENGINEER SALESMAN AS BRANCH MANAGER. Company manufacturing vapor specialties exclusively requires a high-grade engineer capable of preparing heating plans and ability to produce business. Lucrative connection for high-grade man. Drawing account—commission. Give full particulars regarding knowledge of heating, previous affiliation and references. Address Box 102 care Heating and Ventilating Magazine.

WANTED—Engineer with initiative and some knowledge of heating, sprinkler and power-plant design. Technical man having some experience preferred. Location eastern Massachusetts. Apply by letter. Address Box 103 care Heating and Ventilating Magazine.

SALESMAN WANTED—National heating manufacturer wishes to employ five heating engineers with selling experience in the low-pressure installation field. Desirable locations. Limited traveling. Straight salary. Excellent opportunity for men of training and experience. State age, education and business history. Address Box 104 care Heating and Ventilating Magazine.

WANTED.—Ventilating engineer to represents manufacturer of ventilating apparatus on part salary and commission or straight commission. New York and St. Louis territory. Address Box 105, care Heating and Ventilating Magazine.



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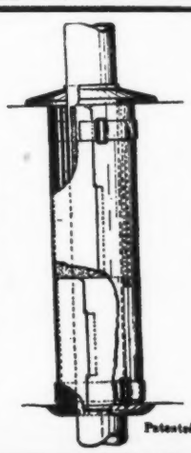

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